NASA SP-7037 (279)
June 1992

AERONAUTICAL ENGINEERING

A CONTINUING BIBLIOGRAPHY WITH INDEXES

NASA STI PROGRAM
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NASA SP-7037 (279)
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AERONAUTICAL ENGINEERING

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NASA National Aeronautics and Space Administration
Scientific and Technical Information Program
Washington, DC 1992

INTRODUCTION

This issue of *Aeronautical Engineering—A Continuing Bibliography* (NASA SP-7037) lists 759 reports, journal articles, and other documents originally announced in May 1992 in *Scientific and Technical Aerospace Reports (STAR)* or in *International Aerospace Abstracts (IAA).*

Accession numbers cited in this issue are:

STAR (N-10000 Series)	N92-18006 — N92-20045
IAA (A-10000 Series)	A92-24399 — A92-28554

The coverage includes documents on the engineering and theoretical aspects of design, construction, evaluation, testing, operation, and performance of aircraft (including aircraft engines) and associated components, equipment, and systems. It also includes research and development in aerodynamics, aeronautics, and ground support equipment for aeronautical vehicles.

Each entry in the publication consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged by the first nine *STAR* specific categories and the remaining *STAR* major categories. This arrangement offers the user the most advantageous breakdown for individual objectives. The citations include the original accession numbers from the respective announcement journals.

Seven indexes—subject, personal author, corporate source, foreign technology, contract number, report number, and accession number—are included.

A cumulative index for 1992 will be published in early 1993.

Information on availability of documents listed, addresses of organizations, and NTIS price schedules are located at the back of this issue.

CONTENTS

TYPICAL REPORT CITATION AND ABSTRACT

NASA SPONSORED

ON MICROFICHE

ACCESSION NUMBER → N92-10979*# United Technologies Research Center, East Hartford, CT. ← CORPORATE SOURCE

TITLE → **DEVELOPMENT OF UNSTEADY AERODYNAMIC ANALYSES FOR TURBOMACHINERY AEROELASTIC AND AEROACOUSTIC APPLICATIONS**

AUTHORS → JOSEPH M. VERDON, MARK BARNETT, KENNETH C. HALL, and TIMOTHY C. AYER Washingtion NASA Oct. 1991 112 p ← PUBLICATION DATE

CONTRACT NUMBER → (Contract NAS3-25425)

REPORT NUMBERS → (NASA-CR-4405; E-6528; NAS 1.26:4405; R91-957907-3) Avail:

AVAILABILITY SOURCE → NTIS HC/MF A06 CSCL 01/1 ← COSATI CODE

PRICE CODE

Theoretical analyses and computer codes are being developed for predicting compressible unsteady inviscid and viscous flows through blade rows. Such analyses are needed to determine the impact of unsteady flow phenomena on the structural durability and noise generation characteristics of turbomachinery blading. Emphasis is being placed on developing analyses based on asymptotic representations of unsteady flow phenomena. Thus, flow driven by small-amplitude unsteady excitations in which viscous effects are concentrated in thin layers are being considered. The resulting analyses should apply in many practical situations, lead to a better understanding of the relevent physics, and they will be efficient computationally, and therefore, appropriate for aeroelastic and aeroacoustic design applications. Under the present phase (Task 3), the effort was foucused on providing inviscid and viscid prediction capabilities for subsonic unsteady cascade flows. Author

TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT

NASA SPONSORED

ACCESSION NUMBER → A92-13210* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA. ← CORPORATE SOURCE

TITLE → **PROBE SHAPES FOR STREAMWISE MOMENTUM AND CROSS-STREAM TURBULENCE INTENSITY**

AUTHOR → VERNON ROSSOW, J. (NASA, Ames Research Center, Moffett Field, CA) Journal of Aircraft (ISSN 0021-8669), vol. 28, Nov. 1991, p. 741-749. refs ← AUTHORS' AFFILIATION

JOURNAL TITLE

Copyright

When the highly turbulent flowfields at the edges of jets, in augmentors, and in other jet-mixing devices are surveyed with conventional pitot probes, the values indicated by the instruments may contain a significant increment brought about by the dynamics of the eddies. Although the influence of turbulence on the measurements is usually negligible in streams where the turbulence level is 1 percent or less, the effect of turbulence on static and total pressure measurements can be around 20 percent when the turbulence level exceeds 40 percent. This paper describes a theoretical study that develops probe shapes that directly measure the time-averaged total pressure based on the streamwise component of the velocity vector to obtain a direct measurement of the streamwise momentum. The difference between the time-averaged pressure indicated by such a probe and one that measures the total head based on the entire velocity vector yields the cross-stream turbulence intensity. Author

AERONAUTICAL ENGINEERING

A Continuing Bibliography (Suppl. 279)

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AERONAUTICS (GENERAL)

A92-25175
THE STEALTH MASTER
BILL SWEETMAN Interavia Aerospace Review (ISSN 0020-6512), vol. 47, Feb. 1992, p. 28-30, 33.
Copyright
A review is presented of the evolution of aircraft stealth technology and the research effort that led to the development of the USAF F-117. Organizational limitations, security restrictions, performance, cost, and schedule targets are described. Consideration is given to the various proposal and contractual events involving the Air Force and Navy programs including the ATB, ATF, ATA, and eventually the F-22. R.E.P.

A92-25178
A COGNITIVE TEMPORAL MODEL FOR THE PLANNING IN AIRCRAFT MAINTENANCE
DENYS BERNARD (SOGERMA-SOCEA, Merignac, France), MARIO BORILLO, and BRUNO GAUME (Toulouse III, Universite, France) IN: IEA/AIE-90; Proceedings of the 3rd International Conference on Industrial and Engineering Applications of Artificial Intelligence and Expert Systems, Charleston, SC, July 15-18, 1990. Vol. 1. Tullahoma, TN, University of Tennessee, 1990, p. 318-324. refs
Copyright
Key maintenance issues are addressed by employing the temporal reasoning model by Kowalski and Sergot (1986) based on events calculus and applying the treatment temporal information relating to aircraft overhaul. The planning problem inherent in aircraft maintenance is defined so that planning issues specific to the field can be incorporated. The model is outlined and generalized, and the maintenance-specific terms and rules are set forth with a sample application. The technique permits the reading of the provisional schedule, the identification of time intervals, and the description of the progress of the maintenance. The cognitive approach extends the reasoning model in a manner that is consistent with conventional human-planning methodologies. The default reasoning model is nonmonotonic, and the task list can be expanded and updated without influencing current data. C.C.S.

A92-25180
THE TSE 310 TROUBLESHOOTING EXPERT PROTOTYPE FOR THE AIRBUS A-310 COMMERCIAL AIRCRAFT
MEHMET H. GOKER and SELAHATTIN KURU (University of the Bosphorus, Istanbul, Turkey) IN: IEA/AIE-90; Proceedings of the 3rd International Conference on Industrial and Engineering Applications of Artificial Intelligence and Expert Systems, Charleston, SC, July 15-18, 1990. Vol. 2. Tullahoma, TN, University of Tennessee, 1990, p. 692-696. Research supported by University of the Bosphorus. refs
Copyright
Using available troubleshooting manuals, mean time between failure data, and the maintenance record of each aircraft the troubleshooting process of an Airbus A-310 is being automated by implementing an expert system (TSE 310). Starting off with the basic troubleshooting tree in the troubleshooting manual the program uses last removal date and mean time between failure data to calculate failure probabilities of the parts connected to the relevant node of the troubleshooting tree, and by using these probabilities traverses the rest of the tree in an intelligent manner to locate the faulty part requiring minimum user intervention. Author

A92-25371
FLEET MODERNIZATION - ONE APPROACH
JAMES H. BRAHNEY Aerospace Engineering (ISSN 0736-2536), vol. 12, Feb. 1992, p. 9-12.
Copyright
It is shown that operators of commercial aircraft have options available to modernize their fleets that do not require the purchase of new aircraft. Some of the options considered include installation of hush kits to meet new noise attenuation rules, complete new higher-rated engines to comply with Stage III noise limits, and upgrading cockpit avionics to include dual analog/digital air data computers, electronic flight instruments, and color radar. R.E.P.

A92-25575
ANGLO-AMERICAN AVIONICS
PETER A. HEARNE Aerospace (UK) (ISSN 0305-0831), vol. 19, Feb. 1992, p. 12-18.
Copyright
An overview is presented of some of the military and civil aviation technical developments that have been accomplished by the special Anglo-American relationship. Attention is given to avionics developments including the Lightning integrated flight control/radar/flight instruments and weapon system and the U.S. Navy's F-14, where the performance of the aircraft, its 100-mile radar, and its long-range Phoenix missile were developed from the beginning as an integrated whole in which aircraft, missile, and electronic system were carefully optimized to meet the point defense problem. Consideration is given to joint endeavors in the fields of integrated circuit semiconductors, digital computing, software systems design, and reliability engineering. R.E.P.

A92-26250
A MODERN VIEW OF THEODORE THEODORSEN
EARL H. DOWELL, ED. (Duke University, Durham, NC) Washington, DC, American Institute of Aeronautics and Astronautics, Inc., 1992, 372 p. No individual items are abstracted in this volume.
(ISBN 0-930403-85-1) Copyright
The present volume is a comprehensive appreciation of the work in experimental and theoretical aerodynamics of Theodore Theodorsen (1897-1978), during his long carreer as USAF Chief Scientist and head of the Physical Research Division of NASA-Langley. Evaluations of Theodorsen's accomplishments are evaluated in the fields of the aerodynamics of wing sections, propeller aerodynamics, the foundations of turbulence, and aeroelasticity. A representative collection of Theodorsen's papers from 1930-1976 is presented; these cover wind tunnel wall interference, aerodynamic instability, the behavior of dual-rotation

ABSTRACTS

propellers, hurricane theory, and the structure of turbulence. O.C.

A92-26792
NEW AIRBUS INDUSTRIE AIRLINERS ON COURSE FOR LONG-HAUL ERA
GEOFF THOMAS (Airbus Industrie, Toulouse, France) ICAO Journal (ISSN 0018-8778), vol. 47, Jan. 1992, p. 4-7.
Copyright
The launching of a combined A330/A340 program has been made possible by development of a common wing, fuselage, and tail as well as utilization of advanced technology systems pioneered by the A320. Originated in the mid-1980s the A330/340 wing has been designed for maximum efficiency utilizing the most advanced aerodynamic techniques and computing power to model airflows in a realistic 3D sense, resulting in a slender and highly efficient wing. R.E.P.

A92-26793
SUPERSONIC TRANSPORT IN THE 21ST CENTURY
DUDLEY COLLARD (Aerospatiale, Toulouse, France) ICAO Journal (ISSN 0018-8778), vol. 47, Jan. 1992, p. 8, 9.
Copyright
It is stated that market studies indicate a requirement for a long-range SST, but such an undertaking will not be possible without extensive international cooperation to develop an environmentally acceptable aircraft. Consideration is given to the potential market, environmental aspects, engine emissions and noise, technical development, and international cooperation. R.E.P.

A92-27448
THE PROBLEM OF AGING AIRCRAFT - IS MANDATORY RETIREMENT THE ANSWER?
ELIZABETH BRANNEN Journal of Air Law and Commerce (ISSN 0021-8642), vol. 57, Winter 1991, p. 425-467. refs
Copyright
The possibility of reaching a level of maintenance and repair that will allow a properly cared for aircraft to fly virtually forever is examined, along with the question of whether there is a point at which an airliner should be retired. The crash of the Aloha Airlines aircraft is discussed, and the various problems associated with the aging of the current American fleet are addressed. The inspection procedures previously used by the FAA are examined and contrasted with the inspection policies recently proposed and implemented by that agency, and the sufficiency of the latter policies is studied. After considering whether legally forced retirement constitutes a taking of property under the Fifth Amendment, it is shown that the new maintenance procedures, if properly implemented and enforced, are the best solution to the growing problem of aging aircraft. C.D.

A92-28492
INDUSTRY SEEKS TONIC FOR AGING AIRCRAFT
ALAN S. BROWN Aerospace America (ISSN 0740-722X), vol. 30, March 1992, p. 24-28, 39.
Copyright
This review of corrosion fatigue and its detection is based on anecdotal data from the aerospace industry and examines the need for more comprehensive and accurate detection methodologies. The principal issues outlined include the novelty of pervasive corrosion fatigue, the safety of aging aircraft, and the economic ramifications of enhancing testing and safety. NDE systems are being developed to address corrosion detection without disassembling aircraft. The lack of both knowledge and compliance in the field are cited as important limiting factors, and reference is made to test methods for inspections and coatings for treatment. The use of more advanced materials for replacement parts and the development of coatings are emphasized as solutions. It is noted, however, that a comprehensive NDE strategy for identifying significant cracks and corrosion damage is needed for adoption as an industry standard. C.C.S.

N92-18322# Manchester Univ. (England). Aeronautical Engineering Group.
THE GOLDSTEIN ENGINEERING RESEARCH LABORATORY
1989 61 p
(AERO-REPT-8906; ETN-92-90941) Avail: NTIS HC/MF A04
The Goldstein Laboratory is situated near Manchester (England). The experimental and computation facilities including an open jet tunnel, low turbulence wind tunnel, shock tubes, small wind tunnels, towing tasks for nonaeronautical fluid phenomena, stratified facilities, pulsating flow rig, and the computer system, are described. Profiles of research staff are given. Recent research programs, including jet noise investigations, computational fluid dynamics, high incidence aerodynamics, pulsating flow in tubes/blood flow in arteries, bluff body wakes, stratified flow, air to air refueling, and vortex dynamics are summarized. ESA

N92-18969# Federal Aviation Administration, Washington, DC.
NATIONAL AIRSPACE SYSTEM MAINTENANCE AND SUPPORT OPERATIONAL CONCEPT
WILLIAM TRENT, THOMAS PICKERELL, and HAROLD NELSON, JR. (Computer Resource Management, Inc., Herndon, VA.) Jan. 1992 53 p
(Contract DTFA01-91-Y-01004)
(DOT/FAA/SE-92/1; NAS-SR-137) Avail: NTIS HC/MF A04
A requirement for the National Airspace System (NAS) is to provide for the maintenance and support of the NAS, as identified in the NAS System Requirement Specification, NAS-SR-1000. Presented here is a concept of operations for maintenance and support. These capabilities are described and the relations among subsystems, facilities, information, and operators/users are shown. The intention is to provide a common perspective for personnel involved in maintenance and support services, assist in determining whether procedures meet formal requirements, and support coordination among the organizations involved. Author

N92-19662# Transportation Research Board, Washington, DC.
PUBLIC-SECTOR AVIATION ISSUES: GRADUATE RESEARCH AWARD PAPERS, 1989 - 1990
1991 63 p Presented at the 70th Transportation Research Board Annual Meeting, Jan. 1991
(PB91-242271; TRB/TRR-1298; LC-91-24111; ISBN-0-309-05107-X) Avail: NTIS HC/MF A04 CSCL 01/2
The following topics are covered: peak-load-congestion pricing of hub airport operations with endogenous scheduling and traffic-flow adjustments at Minneapolis-St. Paul Airport; US Cabotage policy; human orientation and wayfinding in airport passenger terminals; understanding the role of human error in aircraft accidents; analysis of the relationship between financial health and maintenance cost structure of the US airline industry. GRA

N92-19930*# National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
SPACE SHUTTLE ENTRY TERMINAL AREA ENERGY MANAGEMENT
THOMAS E. MOORE Nov. 1991 50 p
(NASA-TM-104744; S-661; NAS 1.15:104744) Avail: NTIS HC/MF A03 CSCL 01/2
A historical account of the development for Shuttle's Terminal Area Energy Management (TAEM) is presented. A derivation and explanation of logic and equations are provided as a supplement to the well documented guidance computation requirements contained within the official Functional Subsystem Software Requirements (FSSR) published by Rockwell for NASA. The FSSR contains the full set of equations and logic, whereas this document addresses just certain areas for amplification. Author

02

AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

A92-24404
EFFICIENT PANEL METHOD FOR VORTEX SHEET ROLL-UP
FRANCOIS LAMARRE and ION PARASCHIVOIU (Ecole Polytechnique, Montreal, Canada) Journal of Aircraft (ISSN 0021-8669), vol. 29, Jan.-Feb. 1992, p. 28-33. refs
Copyright

In order to improve the accuracy of a potential flow three-dimensional wing panel method, wake deformation must be taken into account. This leads to a better knowledge of the large-scale flow behavior. In this paper, a computational method modeling the vortex sheet behind a wing is presented. The sheet deformation is computed using a two-dimensional unsteady analogy in the crossflow plane. The local velocities are induced by linear vorticity panels with smoothed velocity fields. The sheet is rediscretized at each time step with an adaptive curvature-dependent paneling scheme. The vortex sheet model produces good results for the typical cases of elliptic loading, wing/flap configuration, and ring wing. Coupling of the wake model with a three-dimensional wing panel method gives wake geometries that compare well with those obtained with other codes. Author

A92-24407
PREDICTION OF TURBULENT FLOW BEHAVIOR OVER A SLOTTED FLAP
SRINATH S. HERAGU (Aeronautical Development Agency, Bangalore, India) Journal of Aircraft (ISSN 0021-8669), vol. 29, Jan.-Feb. 1992, p. 52-62. refs
Copyright

The slotted flap is a wing trailing-edge device used to reduce the takeoff and landing distances of aircraft by increasing the wing maximum lift coefficient. The flow around the slotted flap, which determines the pressure distribution and effectiveness of the aerofoil system, is affected by the interaction of the wake of the main aerofoil element and the boundary layer on the flap's upper surface. This mathematical model has been developed to provide a viable calculation method, which can predict such an interaction. The system of equations has been developed in an orthogonal curvilinear coordinate system, and the principle of momentum flux balance has been effectively used in conjunction with Coles' profile for the turbulent boundary layer and a Gaussian profile for the wake. Results from this method have been compared to experimental data for three cases of flow over an aerofoil. In each case, it is shown that the displacement and momentum thicknesses, skin friction coefficient, and the merging of the wake and boundary layer predicted by this method are in good agreement with the experiment. Author

A92-24410
NAVIER-STOKES CALCULATIONS OF INBOARD STALL DELAY DUE TO ROTATION
J. C. NARRAMORE (Bell Helicopter Textron, Inc., Fort Worth, TX) and R. VERMELAND (Cray Research, Inc., Mendota Heights, MN) Journal of Aircraft (ISSN 0021-8669), vol. 29, Jan.-Feb. 1992, p. 73-78. Previously cited in issue 18, p. 2754, Accession no. A89-42044. refs
Copyright

A92-24412
RAPID PREDICTION OF HIGH-ALPHA UNSTEADY AERODYNAMICS OF SLENDER-WING AIRCRAFT
H. H. C. KING (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) and L. E. ERICSSON Journal of Aircraft (ISSN 0021-8669), vol. 29, Jan.-Feb. 1992, p. 85-92. Research supported by Lockheed Missiles and Space Co., Inc. Previously cited in issue 21, p. 3286, Accession no. A90-45876. refs
Copyright

A92-24414* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
COMPARISON OF TWO NAVIER-STOKES CODES FOR ATTACHED TRANSONIC WING FLOWS
DARYL L. BONHAUS and STEPHEN F. WORNOM (NASA, Langley Research Center, Hampton, VA) Journal of Aircraft (ISSN 0021-8669), vol. 29, Jan.-Feb. 1992, p. 101-107. Previously cited in issue 21, p. 3290, Accession no. A90-45909. refs
Copyright

A92-24416* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
CORRECTION OF SIDESLIP-INDUCED STATIC PRESSURE ERRORS IN FLIGHT-TEST MEASUREMENTS
EDWIN K. PARKS (Arizona, University, Tucson), RALPH E. BACH, JR., and DUC TRAN (NASA, Ames Research Center, Moffett Field, CA) Journal of Aircraft (ISSN 0021-8669), vol. 29, Jan.-Feb. 1992, p. 114-117. Previously cited in issue 21, p. 3288, Accession no. A90-45898. refs
Copyright

A92-24417
SUPPRESSION OF THE WING-BODY JUNCTION VORTEX BY BODY SURFACE SUCTION
D. B. PHILIPS, J. M. CIMBALA, and A. L. TREASTER (Pennsylvania State University, University Park) Journal of Aircraft (ISSN 0021-8669), vol. 29, Jan.-Feb. 1992, p. 118-122. Research supported by Pennsylvania State University. refs
Copyright

A horseshoe-shaped vortex, known as a wing-body junction vortex or horseshoe vortex, forms when spanwise vorticity in the boundary layer along a surface wraps around a wing protruding from the surface. In the past, various techniques of suppressing the wing-body junction vortex have been attempted. Reported here is a novel approach whereby the oncoming wall boundary layer is removed by suction along the body surface immediately upstream of the wing. The idea is that elimination of the boundary layer essentially removes the spanwise vorticity, and inhibits the formation of a wing-body junction vortex. To test this concept experimentally, velocity data were acquired via five-hole probe surveys in a plane normal to one of the walls of a semi-infinite symmetrical airfoil. Differentiation of these data yielded mean streamwise vorticity contours and values of net circulation. In the unmodified (no suction) case, the streamwise leg of the horseshoe vortex was clearly identified. The addition of suction successfully reduced the size and circulation of the large scale vortex. In fact, at a suction volumetric flow rate of about twice that through the boundary layer, the large scale horseshoe vortex could no longer be found for our configuration. Author

A92-24418
APPROACH TO SIDE FORCE ALLEVIATION THROUGH MODIFICATION OF THE POINTED FOREBODY GEOMETRY
V. J. MODI and A. C. STEWART (British Columbia, University, Vancouver, Canada) Journal of Aircraft (ISSN 0021-8669), vol. 29, Jan.-Feb. 1992, p. 123-130. Previously cited in issue 20, p. 3143, Accession no. A90-45165. refs
(Contract NSERC-A-2181)
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A92-24419
SEPARATION CONTROL USING MOVING SURFACE EFFECTS - A NUMERICAL SIMULATION
A. A. HASSAN (McDonnell Douglas Helicopter Co., Mesa, AZ) and L. N. SANKAR (Georgia Institute of Technology, Atlanta) Journal of Aircraft (ISSN 0021-8669), vol. 29, Jan.-Feb. 1992, p. 131-139. Previously cited in issue 11, p. 1591, Accession no. A89-30486. refs
Copyright

A92-24421
WIND-TUNNEL STUDIES OF F/A-18 TAIL BUFFET
B. H. K. LEE and D. BROWN (National Research Council of Canada, Ottawa) Journal of Aircraft (ISSN 0021-8669), vol. 29, Jan.-Feb. 1992, p. 146-152. Research supported by DND. Previously cited in issue 16, p. 2477, Accession no. A90-37969. refs
Copyright

A92-24422
TRANSONIC AEROELASTICITY ANALYSIS USING STATE-SPACE UNSTEADY AERODYNAMIC MODELING
G. L. CROUSE, JR. and J. G. LEISHMAN (Maryland, University, College Park) Journal of Aircraft (ISSN 0021-8669), vol. 29, Jan.-Feb. 1992, p. 153-160. Previously cited in issue 09, p. 1270, Accession no. A89-25018. refs
Copyright

A92-24426
INFLUENCE OF FLIGHT PARAMETERS ON AIR INTAKE INTERNAL FLOW DISTORTIONS DUE TO GUN BLAST-AIR INTERACTION
J. M. DESSE (ONERA, Institut de Mecanique des Fluides, Lille, France) La Recherche Aerospatiale (English Edition) (ISSN 0379-380X), no. 4, 1991, p. 1-10. refs
Copyright
A simple experimental setup is presented for measuring the nonsteady distortions due to interaction between an aircraft gun blast and an air intake. This setup has been used in a number of wind tunnels to test the effect of flight parameters under downscale conditions. It is chiefly shown that the results are in good agreement with theoretical estimates: the reinforcement of the blast wave as the flight Mach number increases reduces the compressor inflow distortions. On the basis of our similarity rules, it is concluded that, of those configurations tested, it is when an aircraft is flying at a high altitude, at low Mach and with a low intake mass flow rate, that conditions are least favorable. The nonsteady disturbances at the compressor face plane indicate that the main cause of the engine failure seems to be the simultaneous effects of the sudden, protracted loss of static pressure, combined with the large increases in distortions produced by the many reflected waves inside the air intake. Author

A92-24428
ESTABLISHMENT AND CHARACTERIZATION OF A REPRODUCIBLE VORTEX FOR USE IN STUDYING NONSTEADY TWO-DIMENSIONAL PHENOMENA
J. PEUBE and B. FERRET (Poitiers, Universite, France) La Recherche Aerospatiale (English Edition) (ISSN 0379-380X), no. 4, 1991, p. 23-36. refs
(Contract DRET-85-092)
Copyright
When studying the nonsteady phenomena of two-dimensional flows, such as in blade-vortex interactions, the main difficulty in experiments is to create a single vortex of a size and circulation that are of the same order as the corresponding quantities far from the blade. An experimental setup is described that produces a vortex by deep dynamic stall of a small airfoil, oscillating in pitch at high speed, under computer control. This vortex has been characterized by flow visualizations and hot-wire anemometry measurements. The objective of creating a single vortex has not been fully achieved, though, since measurements show that the main vortex is preceded by a small one emanating from the trailing edge, and followed by a second structure of opposite circulation. Author

A92-24599
EFFECT OF SUPERSONIC DIFFUSER GEOMETRY ON OPERATION CONDITIONS
S. V. PUZACH (Moskovskii Gosudarstvennyi Tekhnicheskii Universitet, Moscow, USSR) Experimental Thermal and Fluid Science (ISSN 0894-1777), vol. 5, Jan. 1992, p. 124-128. refs
Copyright
Results are presented of experimental and theoretical studies of characteristics of start-up and stationary conditions of operation of a supersonic diffuser with variable geometry of the wall located in the track of a supersonic wind tunnel with Mach number $M = 2$ and 3 in the working region. The stationary and nonstationary turbulent boundary layers were computed in terms of the asymptotic theory of Kutateladze and Leontiev. The test data show an essential influence of supersonic diffuser geometry on the start-up ratio of pressures on the input and output from the wind tunnel and the flow velocity of the system of shock waves at a 'quasi-stationary' start-up. Theoretical integral characteristics and velocity profiles of a turbulent boundary layer in a supersonic diffuser are in good agreement with the experimental results. Author

A92-24651* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
FLOW OVER AN ALL-BODY HYPERSONIC AIRCRAFT - EXPERIMENT AND COMPUTATION
WILLIAM K. LOCKMAN, SCOTT L. LAWRENCE (NASA, Ames Research Center, Moffett Field, CA), and JOSEPH W. CLEARY (Eloret Institute, Sunnyvale, CA) Journal of Spacecraft and Rockets (ISSN 0022-4650), vol. 29, Jan.-Feb. 1992, p. 7-15. Previously cited in issue 21, p. 3288, Accession no. A90-45893. refs
Copyright

A92-24652* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
APPLICATION OF THE LAURA CODE FOR SLENDER-VEHICLE AEROTHERMODYNAMICS
RICHARD A. THOMPSON and PETER A. GNOFFO (NASA, Langley Research Center, Hampton, VA) Journal of Spacecraft and Rockets (ISSN 0022-4650), vol. 29, Jan.-Feb. 1992, p. 16-23. Previously cited in issue 16, p. 2478, Accession no. A90-38416. refs
Copyright

A92-24653* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
IMPROVED NONEQUILIBRIUM VISCOUS SHOCK-LAYER SCHEME FOR HYPERSONIC BLUNT-BODY FLOWFIELDS
BILAL A. BHUTTA and CLARK H. LEWIS (VRA, Inc., Blacksburg, VA) Journal of Spacecraft and Rockets (ISSN 0022-4650), vol. 29, Jan.-Feb. 1992, p. 24-34. refs
(Contract NAS3-25450)
Copyright
The nonequilibrium viscous shock-layer (VSL) solution scheme is revisited to improve its solution accuracy in the stagnation region and also to minimize and control errors in the conservation of elemental mass. The stagnation-point solution is improved by using a second-order expansion for the normal velocity, and the elemental mass conservation is improved by directly imposing the element conservation equations as solution constraints. These modifications are such that the general structure and computational efficiency of the nonequilibrium VSL scheme is not affected. This revised nonequilibrium VSL scheme is used to study the Mach 20 flow over a 7-deg sphere-cone vehicle under 0- and 20-deg angle-of-attack conditions. Comparisons are made with the corresponding predictions of Navier-Stokes and parabolized Navier-Stokes solution schemes. The results of these tests show that the nonequilibrium blunt-body VSL scheme is indeed an accurate, fast, and extremely efficient means for generating the blunt-body flowfield over spherical nose tips at zero-to-large angles of attack. Author

A92-24667
MULTIZONAL NAVIER-STOKES SOLUTIONS FOR THE MULTIBODY SPACE SHUTTLE CONFIGURATION
C. L. CHEN, S. RAMAKRISHNAN, K. Y. SZEMA (Rockwell International Science Center, Thousand Oaks, CA), H. S. DRESSER, and K. RAJAGOPAL (Rockwell International Corp., Space Div., Downey, CA) Journal of Spacecraft and Rockets

(ISSN 0022-4650), vol. 29, Jan.-Feb. 1992, p. 129-137. Previously cited in issue 08, p. 1103, Accession no. A90-22217. refs
Copyright

A92-24724
ON THE PREDICTION OF UNSTEADY FORCES ON GAS TURBINE BLADES. I - DESCRIPTION OF THE APPROACH. II - ANALYSIS OF THE RESULTS
T. KORAKIANITIS (Washington University, Saint Louis, MO) ASME, Transactions, Journal of Turbomachinery (ISSN 0889-504X), vol. 114, Jan. 1992, p. 114-131. Research supported by General Electric Co. refs
Copyright

The generation of unsteady forces on turbine blades due to potential-flow interaction and viscous-wake interaction from upstream blade rows is investigated. A computer program is employed to calculate the unsteady forces on the rotor blades. The interaction mechanism demonstrates variation with the stator-to-rotor-pitch ratio and with the outlet flow angle of the stator. It is shown that varying the axial gap between stator and rotor can minimize the magnitude of the unsteady part of the forces generated by the combined effects of the two interactions.

A92-24725
DESIGN OF TURBOMACHINERY BLADING IN TRANSONIC FLOWS BY THE CIRCULATION METHOD
T. Q. DANG (Syracuse University, NY) ASME, Transactions, Journal of Turbomachinery (ISSN 0889-504X), vol. 114, Jan. 1992, p. 141-146. Research sponsored by Rockwell International Corp. refs
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The newly developed three-dimensional design technique for turbomachinery blading based on the circulation method has been successfully extended into the transonic flow regime. The main task involves replacing the classical Fourier series expansion technique by a finite-volume method. Calculations were carried out for the design of infinitely thin cascaded blades in transonic flows, including shocked and shock-free cascaded blades.
Author

A92-24731
A RANDOM VORTEX METHOD FOR PREDICTION OF MAXIMUM INSTANTANEOUS INLET TOTAL PRESSURE DISTORTION
HU WU and FUQUN CHENG (Northwestern Polytechnical University, Xian, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, Jan. 1992, p. 14-16. In Chinese. refs

An improved random vortex model for predicting maximum instantaneous pressure distortion is presented based on the statistical behavior of the turbulence-type dynamic inlet total field generated by a plate-type turbulence generator. A new statistical method is proposed for determining the vortex core size. The numerical results show good accuracy of the prediction. This method also decreases the dynamic inlet pressure measurements. The effectiveness of the method in decreasing both cost and time is proved.
Author

A92-24876
A SIMPLIFIED METHOD FOR SIMULATING STEADY, UNSTEADY FLOW AROUND CANARD WING CONFIGURATION
ZHENGYIN YE (Northwestern Polytechnical University, Xian, People's Republic of China) Northwestern Polytechnical University, Journal (ISSN 1000-2758), vol. 10, Jan. 1992, p. 1-6. In Chinese. refs

A simplified technique to calculate the steady or unsteady flow around canard-wing configurations is presented. An improved unsteady nonlinear vortex lattice method is employed to simulate the wing, while the canard and its free vortex sheet are modeled with an equivalent concentrated vortex. In this method the position of the equivalent concentrated vortex in the flow field is determined simultaneously with the position of the free vortex sheet shed from the wing.
R.E.P.

A92-24877
ON VELOCITY PROFILE MODELS FOR PREDICTING END WALL BOUNDARY LAYERS AND THEIR BLADE FORCE DEFECTS IN AXIAL COMPRESSOR CASCADES
HU WU, SONGLING LIU, and FUQUN CHEN (Northwestern Polytechnical University, Xian, People's Republic of China) Northwestern Polytechnical University, Journal (ISSN 1000-2758), vol. 10, Jan. 1992, p. 7-13. In Chinese. refs

The effect of velocity profile models and tip clearance on the prediction of end-wall boundary layers inside the cascade passages of axial compressors is discussed. It is seen that models for 3D velocity profile and blade force, respectively, are required to predict these end-wall boundary layers. Results indicate that by selecting the correct model and utilizing a new model of blade force defect, the prediction of end-wall boundary layers inside the cascade passages of axial compressors can be made with precision.
R.E.P.

A92-24902
ON ONE METHOD OF CONSTRUCTING ADAPTIVE DIFFERENCE GRIDS IN AERODYNAMICS PROBLEMS
V. I. PINCHUKOV (Academy of Sciences of the USSR, Institute of Theoretical and Applied Mechanics, Novosibirsk) Russian Journal of Theoretical and Applied Mechanics (ISSN 1051-8045), vol. 1, Sept. 1991, p. 221-228. refs
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A method for constructing grids in 2D domains based on a numerical solution of elliptic equations derived by Winslow (1966) and Thompson et al. (1982) is described. The proposed algorithm for constructing difference grids makes it possible to improve the quality of the flow structure resolution in numerical simulation of flows. The algorithm is considered to be effective in terms of computer costs. Examples of calculation of flows with shock waves adaptive to solution grids are presented.
O.G.

A92-24904
APPLICATION OF SPECIAL SERIES FOR STUDYING NONSTATIONARY TRANSONIC GAS FLOWS
M. IU. FILIMONOV (Academy of Sciences of the USSR, Institute of Mathematics and Mechanics, Sverdlovsk) Russian Journal of Theoretical and Applied Mechanics (ISSN 1051-8045), vol. 1, Sept. 1991, p. 235-241. refs
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Solutions to the equations of nonstationary transonic gas flows in the form of a special series are presented which depend on an arbitrary function of one argument. The convergence domain of these series are studied, and it is shown that they may be used on an infinite time interval for the approximate solution of the Cauchy mixed problems. The application of special basic functions containing an arbitrary function of one argument makes it possible to successively calculate series coefficients from systems of linear ordinary differential equations. Through these series coefficients, additional boundary conditions can be accurately satisfied.
O.G.

A92-24976
ON MARCHING ALGORITHMS FOR SOLVING STATIONARY PROBLEMS
V. M. KOVENIA and S. G. CHERNYI (Academy of Sciences of the USSR, Institute of Theoretical and Applied Mechanics, Novosibirsk) Russian Journal of Theoretical and Applied Mechanics (ISSN 1051-8045), vol. 1, March 1991, p. 1-13. refs
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Stationary equations and iterative marching algorithms are developed which can be employed to numerically describe supersonic flows approximating gas dynamics. The unconditionally stable algorithms are based on the splitting of initial equations according to physical processes and spatial directions, and some are developed in real time. The schemes are implemented by means of scalar sweeps at each fractional step, and numerical

examples demonstrate the applicability of the method for shock waves and viscous gas equations. C.C.S.

A92-24979
PROBLEMS OF LAMINAR-TURBULENT TRANSITION CONTROL IN A BOUNDARY LAYER
A. V. FEDOROV, V. IA. LEVCHENKO, and A. M. TUMIN (Academy of Sciences of the USSR, Institute of Theoretical and Applied Mechanics, Novosibirsk; Moscow Physical-Technical Institute, USSR) Russian Journal of Theoretical and Applied Mechanics (ISSN 1051-8045), vol. 1, March 1991, p. 85-101. refs
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The overview of laminar-turbulent transition control compares different methods of transition control for swept-wing streams. The types of unstable disturbances in boundary layer are listed, and flow stabilization is described in terms of small disturbances. The control of the transition zone is based on the description of background disturbances, their transition into instability waves, and their linear and nonlinear amplifications. Specific references cite the applications to Tollmien-Schlichting waves, crossflow instability near an aircraft's leading edge, and unstable disturbances in a boundary layer over a curved surface. Methods of active control or wave cancellation to deal with the problem are listed including localized periodic heating, the introduction of vibrations, or the use of suction-blowing. The results of the comparative overview are of interest to aircraft and other aerospace applications to reduce drag and improve fuel efficiency. C.C.S.

A92-25001
FLOW ANALYSIS OF RECTANGULAR WIND TUNNEL CONTRACTION
CHAOQIANG LIN, YAOXI SU, and LIU HONG (Northwestern Polytechnical University, Xian, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 9, Dec. 1991, p. 379-386. In Chinese. refs

In connection with the design of a low-speed wind tunnel, a numerical investigation of the flow in a rectangular contraction has been conducted. The finite difference method is employed using body-fitted coordinates and the AF1 scheme, and solved by the ADI technique. Flows in three commonly used contour curves are analyzed, including the Witozinsky curve, fifth-power curve, and matched cubic curves. Three-dimensional features of the contraction flow are demonstrated in the calculation. The adverse pressure gradient at the corner and the velocity nonuniformity at the exit cross section are calculated and examined. Author

A92-25002
AN EXPERIMENTAL STUDY OF THE FLOW PAST SPHERES AT TRANSONIC SPEEDS AND HIGH REYNOLDS NUMBERS
YINGXIANG WU, ZHICHU ZHENG, and TONGJI LIN (Chinese Academy of Sciences, Institute of Mechanics, Beijing, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 9, Dec. 1991, p. 387-393. In Chinese. refs

To eliminate the disturbance of the model support and the tunnel choking effect and to reduce the influence of the wall, experiments were conducted in a ballistic range in which the absolute pressure can be varied from 0.01 to 0.6 MPas to simulate the free flight of spheres at transonic speeds and high Reynolds numbers. The test Reynolds numbers based on the diameters of the spheres are in the range of 10 exp 5 - 10 exp 6. A number of shadowgraph pictures showing the flow patterns including bow shock, separated shock, the location of the separation, base flow, and wake flow are obtained. Author

A92-25004
NUMERICAL SIMULATION OF 2-D SEPARATED FLOWS CAUSED BY SUDDENLY CHANGE OF THE BODY SECTION
WEIJIANG ZHOU and YANWEN MA (Beijing Institute of Aerodynamics, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 9, Dec. 1991, p. 402-409. In Chinese. refs

The 2D separated flows caused by a sudden change of the body section were studied by numerically solving N-S equations. The differential equations were approximated by a one-step two-order finite difference scheme. Firstly, th near wake flow was calculated. Secondly, the effect of freestream Mach and Reynolds number on flow around a backward-facing step was researched. The results agree with theory and data from other calculations. Author

A92-25009
FINITE ELEMENT METHOD FOR COMPUTING NONISENTROPIC POTENTIAL TRANSONIC FLOW WITH SHOCK WAVES
SHOUQIN YU and QINGBING ZHANG (Nanjing Aeronautical Institute, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 9, Dec. 1991, p. 442-448. refs

The traditional Galerkin full potential finite element is modified, and a nonisentropic potential equation for transonic flow with shock waves is formulated. In this procedure, the mass densities downstream of the shock and the Kutta condition are modified using the entropy jumps across the shock, but the simplicity of the full potential equation is retained. Numerical computations for an airfoil and a wing are presented. It is demonstrated that the modification improves the results and leads to weaker shocks as the position moves upstream. Author

A92-25012
PITCHING DERIVATIVES OF WING IN SUPERSONIC AND HYPERSONIC STREAM - METHOD FOR LOCAL FLOW PISTON THEORY
JINGSONG CHEN (Nanjing Aeronautical Institute, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 9, Dec. 1991, p. 469-476. In Chinese. refs

An approximate analytical method is developed by which pitching derivatives are predicted for three-dimensional wings with a pointed leading edge in supersonic and hypersonic stream. The analytical method is obtained using the local flow piston theory plus the strip theory. The present method is valid for wings of rather general planform and a pointed leading edge at arbitrary mean angles of attack, provided the shock wave is attached to the leading edge of the wing. The numerical results at small and middle angles of attack are compared with experimental data and existing theories. Author

A92-25015
ANALYSIS OF TRANSONIC FLOW PAST AN AXISYMMETRIC CONVEX CORNER
KEMING CHENG (Nanjing Aeronautical Institute, People's Republic of China) and TONGJI LIN (Chinese Academy of Sciences, Institute of Mechanics, Beijing, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 9, Dec. 1991, p. 495-501. In Chinese. refs

In the context of transonic flow past a body of revolution with a cone-cylinder-boattail configuration, transonic flow past an axisymmetric convex corner is discussed. The characteristics and law of the corner flow are presented, and a comparison is made between the corner flow and the corresponding Prandtl-Meyer type expansion in the two-dimensional flat-plane case. Author

A92-25038
COMPUTATIONS OF THE FLOW PAST BODIES AND WINGS USING EULER EQUATIONS
MINGKE HUANG (Nanjing Aeronautical Institute, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 9, March 1991, p. 14-20. In Chinese. refs

A computer program named EU3VOL has been developed based on Jameson's finite volume method for 3D Euler equations. The computation uses an explicit four-stage Runge-Kutta scheme and implicit residual smoothing to accelerate convergence. The program uses C-O and H-O meshes to enable it to apply to the computation of flow past bodies with blunt or pointed noses and to the forebodies with canopies and high-swept slender wings or wing-body combinations. Computational results for flows past such bodies are presented. C.D.

A92-25039
NUMERICAL SIMULATION OF SUPERSONIC SEPARATED FLOW OVER BLUNT CONES AT HIGH ANGLES OF ATTACK
QING SHEN, SHUCHUN GAO, and HANXIN ZHANG (China Aerodynamics Research and Development Center, Mianyang, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 9, March 1991, p. 21-28. In Chinese. refs
A space-marching technique for solving parabolized Navier-Stokes equations recently developed by Zhang and successfully applied to axisymmetrical flows over blunt cones is extended here to the calculation of flow fields with cross-flow separation at high angles of attack. A Beam-Warming implicit difference scheme is utilized. The calculated region is the flow field with thin subsonic layer and viscosity. Satisfactory results are obtained for a blunt cone at high angle of attack. Special attention is given to the separated flow pattern at high angle of attack. C.D.

A92-25040
SPACE-MARCHING CALCULATIONS OF HYPERSONIC INVISCID FLOWFIELD
YOUDA YE (National University of Defence Technology, People's Republic of China), HANXIN ZHANG, and ZHIQUAN GUO (China Aerodynamics Research and Development Center, Mianyang, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 9, March 1991, p. 29-36. In Chinese. refs
This paper generalizes the NND scheme of Zhang to the predictor-corrector two-step two-order scheme in space marching calculations. The shock-capturing properties of the scheme are examined by considering the problem of regular reflection of an oblique shock wave on a flat plate, and the effects of different flux splitting method on shock-capturing capability are investigated. The results of these numerical experiments are satisfactory. The scheme is also used in space-marching calculations of hypersonic inviscid flow field of a modified Space Shuttle Orbiter. The numerical results clearly show the interaction of the body shock wave and the wing shock wave. C.D.

A92-25041
STUDY OF NUMERICAL COMPUTATION OF INVISCID FLOW FIELD ABOUT COMPLEX CONFIGURATION OF RE-ENTRY VEHICLE
ZHIQUAN GUO (China Aerodynamics Research and Development Center, Mianyang, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 9, March 1991, p. 37-45. In Chinese. refs
A marching and iteration method for solving unsteady Euler equations is studied, and a nonoscillatory method dissipative scheme containing no free parameter has been developed into an implicit upwind scheme. The scheme is used to calculate inviscid supersonic flow around a complex reentry vehicle containing controlling wings with angle of attack and sideslip angle taken into account. Numerically accurate results are obtained. The method has also been used to compute flow fields about the dented configuration of a burned forebody and about a modified Space Shuttle configuration. C.D.

A92-25042
NUMERICAL SIMULATIONS OF FLOW FIELDS OVER AIRCRAFTS
YULUN ZHANG, ZUOBIN CHEN (China Aerodynamics Research and Development Center, Mianyang, People's Republic of China), and LIN CHENG (Chengdu Aircraft Co., People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 9, March 1991, p. 46-50. In Chinese. refs
A numerical method to predict the flow fields of subsonic, transonic, and supersonic flows over real aircraft is presented which uses Euler equations as a mathematical model and a high-accuracy TVD scheme. The resulting difference equations are solved with approximate factorization method and forward and back space marching algorithm. Several test calculations show that this method can simulate flow fields over real aircraft. C.D.

A92-25043
NUMERICAL SIMULATION OF INVISCID FLOW OVER A COMPLICATED BODY USING AN OVERLAPPING GRID TECHNIQUE
YONGJIAN YANG and LUMIN ZHANG (China Aerodynamics Research and Development Center, Mianyang, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 9, March 1991, p. 51-57. In Chinese. refs
An inviscid complex of interaction flow over a launch vehicle with four strap-ons is calculated using the split coefficient matrix method of Euler equations using the overlapping grid technique. To capture shocks, the monotonic self-adjusting hybrid scheme is used for the space-marching Euler equations. The numerical results show that all the significant features of an inviscid supersonic flow over composite bodies are obtained. Multiple shock reflection and pressure oscillations between the core and the strap-on can be obtained by the method. C.D.

A92-25048
SINGULAR PERTURBATION THEORY OF HYPERSONIC FLOW OVER BLUNT BODIES
CHAOQIANG LIN (Northwestern Polytechnical University, Xian, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 9, March 1991, p. 139-146. In Chinese. refs
The hypersonic flow parameter orders the near blunt body surface are investigated. The asymptotic expansions of Chernyi are used as the outer solution while the new asymptotic expansions valid for the flow field near the body surface are introduced as the inner solution. The problem is solved by the matched asymptotic expansion method of singular perturbation theory. Explicitly analytical expressions are also given for the solution of the leading terms in the asymptotic expansions. C.D.

A92-25096
THE USE OF VARIABLE CAMBER TO REDUCE DRAG, WEIGHT AND COSTS OF TRANSPORT AIRCRAFT
J. J. SPILLMAN (Cranfield Institute of Technology, England) (Royal Aeronautical Society, Lecture, London, England, Dec. 3, 1991) Aeronautical Journal (ISSN 0001-9240), vol. 96, Jan. 1992, p. 1-9. refs
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Ways in which aircraft wings can achieve variable camber are investigated to obtain near optimum conditions over most of the possible flight conditions. It is concluded that variable camber makes it possible to choose the sectional shape of the wing to give minimum profile drag at any cruise flight condition. The variable camber provides direct lift control which accelerates the response to pilot-initiated maneuvers. By dividing the camber flaps into six or more spanwise segments the spanwise distribution of lift can be selected to minimize drag in the cruise, avoid buffet or stalling problems near the wing tips, and reduce wing bending moment in high maneuver or gust conditions. A high level of static pitch stability can be used to maximize gust alleviating response, since rapid changes in incidence are not required for maneuvers. O.G.

A92-25097
END PLATE INTERFERENCE EFFECTS ON THE AERODYNAMICS OF A CIRCULAR CYLINDER IN UNIFORM FLOW
T. A. FOX (Queensland, University, St. Lucia, Australia) Aeronautical Journal (ISSN 0001-9240), vol. 96, Jan. 1992, p. 10-14. refs
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Results are presented of an investigation into the interference effects associated with end plates of a type commonly used for the simulation of infinitely long 2D cylinder flow conditions around models confined with the working section of a wind tunnel. Experiments were performed with smooth circular cylinders of low area blockage in steady, low-turbulence, uniform airflow at a Reynolds number of 4.4 x 10 exp 4 and involved the measurement of vortex shedding frequencies in the wake of the body, together with mean and fluctuating surface pressures, from which coefficients of local mean drag, rms lift and rms drag were

calculated, and the use of a surface flow visualization technique. The results reveal the aerodynamic characteristics of the disturbance induced by an end plate within the interference region which extends to 3.5 diameters from each plate. Author

A92-25098

A BOUNDARY ELEMENT METHOD FOR THE POTENTIAL, COMPRESSIBLE AERODYNAMICS OF BODIES IN ARBITRARY MOTION

M. GENNARETTI and L. MORINO (Roma I, Universita, Rome, Italy) Aeronautical Journal (ISSN 0001-9240), vol. 96, Jan. 1992, p. 15-19. Research supported by Centro Italiano Ricerche Aerospaziali. refs

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An integral equation and the corresponding boundary-element method are presented for the aerodynamic analysis of compressible, subsonic, potential flows around bodies in arbitrary motion. The formulation has been validated for the case of a hovering rotor. The wake geometry obtained through an incompressible free-wake analysis is used for a prescribed-wake analysis of compressible flows. This procedure gives results which are in good agreement with the experimental data. A comparison with low-Mach-number results shows that the algorithm is capable of correctly predicting the compressibility effects. It is demonstrated that the Prandtl-Glauert-correction procedure overestimates the compressibility effects. O.G.

A92-25101

THE ROLLING-UP AND INTERACTION OF THE LEADING-EDGE AND TRAILING-EDGE VORTEX SHEETS OF A DELTA WING

XIN JIN (Beijing Institute of Aerodynamics, People's Republic of China) and HUIYANG MA (University of Science and Technology of China, Hefei, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 9, Sept. 1991, p. 294-299. In Chinese. refs

The rolling-up of the leading-edge vortex sheet and interaction with the trailing-edge vortex are simulated numerically by using the two-dimensional unsteady analogue and vortex-in-cell method. By using several thousands of point vortices and small space mesh, the large scale discrete vortices on the vortex sheet are obtained as a result of the pairing of small point vortices, thus simulating the instability phenomena of the rolling-up vortex sheet. Author

A92-25103

A NUMERICAL METHOD FOR SOLVING THE CIRCULATION CONTROL AIRFOIL WITH WALL JET

XIANFU WANG and XINMIN XIONG (Wuhan University of Water Transportation Engineering, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 9, Sept. 1991, p. 308-315. In Chinese. refs

This paper presents the viscous inviscid interaction techniques for calculating the flow on the circulation controlled airfoil with tangential jet blowing from surface slots. The calculation models are given to solve potential velocity distribution on the sail airfoil of large attack angle and quasi-elliptic airfoil in two-dimensional separated flows. The viscous problem is calculated by modified Spalding's unified boundary layer theory. Several representative sample cases are calculated and many aerodynamic characteristics are obtained. The solutions generally agree with available computation and experimental results. Author

A92-25104

MULTIPLE LINE-VORTEX MODEL OF VORTEX FLOWS AROUND BODY OF REVOLUTION AT HIGH ANGLES OF ATTACK UP TO 60 DEGREES

WU ZHANG (Beijing University, People's Republic of China), SHIJUN LUO (Northwestern Polytechnical University, Xian, People's Republic of China), and PEIYE ZHU (China Aeronautical Establishment, Institute for Computing Technology, Xian, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 9, Sept. 1991, p. 316-323. refs

This paper deals with the computation of the symmetric and asymmetric vortex flows around a body of revolution at high angles of attack and low speed by means of an improved multiple line-vortex model. With given symmetric or asymmetric separation lines on the body surface, vortex strengths and free vortex locations are solved by an efficient iteration method. The first converged solution at angles of attack up to 60 deg is obtained by using the method. Calculated results of aerodynamic loads on a tangent-ogive forebody compare favorably with experimental data. Author

A92-25107

A NUMERICAL METHOD FOR UNSTEADY TRANSONIC FLOW ABOUT WINGS WITH CONTROL SURFACE

TAO YU and JIANBAI ZHANG (China Aerodynamics Research and Development Center, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 9, Sept. 1991, p. 338-343. In Chinese. refs

A numerical method is presented for predicting unsteady transonic aerodynamic flow about aircraft wings with control surface. The numerical procedure solves the unsteady transonic modified three-dimensional small perturbation equation by time accurate alternating direction implicit finite difference scheme. As a computational example, the steady and unsteady aerodynamic force of F-5 wing with control surface oscillations is considered. Solutions are presented for two Mach numbers, 0.9 and 0.925, and compared with the foreign experimental data and XTRAN3S method. The comparison is shown to be successful. Author

A92-25126

NUMERICAL SIMULATION AND ANALYSIS FOR HYPERSONIC FLOW WITH SEPARATION OVER BLUNT CONE AT ANGLE OF ATTACK

HANXIN ZHANG, QING SHEN, and SHUCHUN GAO (China Aerodynamics Research and Development Center, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 9, June 1991, p. 160-175. In Chinese. refs

The nature of an open separation is qualitatively analyzed and a numerical simulation of the hypersonic flow with an open separation over the blunt cone at angle of attack is performed. The spatial flow pattern of an open separation of the kind first proposed by Wang (1990) is studied. Cross flow separation exists along the separation line and begins from the starting point of an open separation line. There is no streamline passing through a starting point on the separated flow surface except for the separation line itself. C.D.

A92-25127

RECENT PROGRESS IN FINITE ELEMENT METHOD AND BOUNDARY INTEGRAL EQUATION METHOD FOR NONVISCOUS TRANSONIC FLOWS

ZUOSHENG YANG (Nanjing Aeronautical Institute, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 9, June 1991, p. 176-189. In Chinese. refs

Recent progress in the FEM and boundary integral equation method for nonviscous transonic flows is reviewed. Emphasis is given to the USE, block-structured finite element grid generation technique, finite element multigrid technique, the SUPG FEM, the GMRES algorithm, and the pure boundary integral equation method for compressive flows. C.D.

A92-25129

TIME MARCHING INTEGRAL EQUATION METHOD FOR THE SOLUTIONS OF UNSTEADY TRANSONIC FLOWS

JICHAO SU and LIYI WU (Beijing University of Aeronautics and Astronautics, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 9, June 1991, p. 200-208. In Chinese. refs

A time-marching integral equation method (TMIEM) has been developed which eliminates the limitation of the time-linearized integral equation method inability to simulate satisfactorily the shock wave motion. The TMIEM retains the advantages of fast convergence and less CPU time of the steady integral equation method and the time-linearized integral equation method. The

fundamental ideas of TMIEM are examined and the method is implemented for 2D unsteady transonic flows. The usefulness of the TMIEM is shown for some typical flows over airfoils. The three types of shock wave motion experimentally observed by Tijdeman and Seebass have been successfully calculated using TMIEM. Preliminary numerical calculations show that the time-marching integral equation method can satisfactorily solve the problems of shock wave motion. C.D.

A92-25132
ON THE SENSITIVITY OF TRANSONIC FLOW
KEMING CHENG (Nanjing Aeronautical Institute, People's Republic of China) and TONGJI LIN (Chinese Academy of Sciences, Institute of Mechanics, Beijing, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 9, June 1991, p. 226-232. In Chinese. refs

A large number of experimental findings are used here to analyze the variation of the structure of the transonic flow field over a slender cone-cylinder with free-stream Mach number M(infinity). A peculiar sensitivity feature is demonstrated in the variation of the flow over the cylinder with incoming M(infinity), and the concept of transonic upper and lower sensitivity Mach numbers is deduced. It is shown that the transonic flow over the cylinder is not always sensitive over the entire transonic regime. The most sensitive region lies in an interval bounded by the upper and lower Mach numbers. C.D.

A92-25134
APPLICATION OF THE WALL PRESSURE METHOD TO WALL INTERFERENCE CORRECTIONS FOR MODEL TESTS AT HIGH ANGLE OF ATTACK IN HIGH SPEED WIND TUNNEL
ZHAOLIN FAN, NAIMING CUI, and QILIN YUN (China Aerodynamics Research and Development Center, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 9, June 1991, p. 243-250. In Chinese. refs

A method is presented in which wall interference correction for model tests at high angles of attack is conducted in high-speed wind tunnels using as the boundary condition the static pressures measured on the control surface near the wall. Measurements of wall pressure and simulations of walls, model, wake, and separations are presented in detail. A practical example is used to show the accuracy and effectiveness of the method, which is applicable to wall interference correction in rectangular test sections with perforated walls when the blockage of the model is not too large, the angle of attack is not greater than 25 deg, and the flow near the walls is subcritical. C.D.

A92-25136
THE LATERAL SHOCK WAVE FAMILY ON THE SURFACE OF A CONE-CYLINDER IN TRANSONIC FLOWFIELD
KEMING CHENG (Nanjing Aeronautical Institute, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 9, June 1991, p. 256-259. In Chinese. refs

The lateral shock wave family generated on the surface of a cone-cylinder flying at transonic speeds is discussed based on experimental results. The variation of the wave family distribution with free-stream Mach number is analyzed. The relation between the formation of the family and the flow field flow mechanism is discussed, and the reasons for the formation of the wave family is explained. A method for simulating the family is presented, and practical applications of lateral wave family research are discussed. C.D.

A92-25140
THE STUDY OF INVERSE BOUNDARY LAYER ALGORITHM FOR TRANSONIC FLOWS OVER AEROFOILS
YOURONG LI, YULUN ZHANG, and ZUOBIN CHEN (China Aerodynamics Research and Development Center, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 9, June 1991, p. 275-279. In Chinese. refs

A viscous/inviscid interaction model is used here to solve transonic flows over 2D airfoils based on the finite difference method. Laminar, transition, and turbulent flow are taken into account in the viscous layer. The inverse boundary layer algorithm is used when the flow is separated, and an algebraic model is adopted for the turbulent flow. The results show that the method is in good agreement with wind tunnel experimental results for both weak and strong interaction cases between the shock wave and the boundary layer. The method is also suitable for boundary layers with separation bubbles. C.D.

A92-25299
CONSTRUCTION OF AERODYNAMIC PROFILES [O POSTROENII AERODINAMICHESKIKH PROFILEI]
V. D. KOTELKIN Moskovskii Universitet, Vestnik, Seriia 1 - Matematika, Mekhanika (ISSN 0579-9368), Sept.-Oct. 1991, p. 86-88. In Russian. refs
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An approach to the solution of the reverse problem of airfoil design for optimal pressure distribution along the chord is presented. A mathematical formulation of the problem is presented in terms of four simple relations. The direct nonlinear problem of flow past the NACA-0012 airfoil at M 0.7 and an angle of attack of 2 deg is considered as an example. V.L.

A92-25374
NUMERICAL SIMULATION OF TWIN-JET IMPINGEMENT ON A FLAT PLATE COUPLED WITH CROSS-FLOW
SHU-HAO CHUANG (National Chunghsing University, Taichung, Republic of China), MING-HUA CHEN (Chung-Chou Institute of Technology, Changhua, Republic of China), SHEN-WU LII (National Chunghsing University, Taichung, Republic of China), and FANG-MEI TAI (Shu-Teh Junior College of Technology, Taichung, Republic of China) International Journal for Numerical Methods in Fluids (ISSN 0271-2091), vol. 14, Feb. 28, 1992, p. 459-475. refs
Copyright

Theoretical research to simulate twin-jet impingement with cross-flow was undertaken. An impinging twin-jet coupled with cross-flow in closed ground effect was studied by using the compressible Navier-Stokes equation with a Jones-Launder k-epsilon two-equation turbulence model. The velocity results without cross-flow were compared with the data of Saripalli et al. (1986) and found to agree. The calculated results show that several recirculating zones are distributed around the flowfield. Their size and location are closely related to the jet-exit height above the ground, the nozzle space and the strength of cross-flow. In addition, a fountain-upwash flow occurs between the nozzles, and two low-pressure recirculating zones are induced by the interaction between the nozzle mainstream and the fountain-upwash flow. This induces a loss of lift force of the aircraft. The effects of the cross-flow induce the sudden decrease in the lift force of the aircraft; the stronger the cross-flow, the lower is the lift force of the flowfield. Author

A92-25506
ANALYSIS OF A 2-D AIRFOIL MOTION FLYING IN-PROXIMITY-TO A WAVY-WALL SURFACE-LIFTING SURFACE-SCHEME
SHIGENORI ANDO, TETSU SAKAI, and KYOKO NITTA Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 39, no. 455, 1991, p. 680-685. In Japanese. refs

An analysis of a 2D thin airfoil motion is presented for cases when it flies over and in proximity to a wavy-wall surface in an incompressible inviscid flow. Lifting surface technique is used. The results of computation agree satisfactorily with ones of another scheme, which is based on a finite difference method. Efficient integral domain on the wall surface is carefully settled. Some computations are included which suggest the effect of many parameters on WIG seaworthiness. Author

A92-25576* National Aeronautics and Space Administration, Washington, DC.
VORTEX MODELING FOR ROTOR AERODYNAMICS - THE 1991 ALEXANDER A. NIKOLSKY LECTURE

ROBIN B. GRAY (Georgia Institute of Technology, Atlanta) American Helicopter Society, Journal (ISSN 0002-8711), vol. 37, Jan. 1992, p. 3-14. Research supported by U.S. Army, Georgia Institute of Technology, NASA, et al. refs
Copyright
The efforts toward realistic vortex modeling for rotary wings which began under the guidance of professor A. A. Nikolsky of Princeton University in 1955-1956 are discussed. Attention is given to Nikolsky's flow-visualization studies and major theoretical considerations for vortex modeling. More recent efforts by other researchers have led to models of increasing complexity. The neglect of compressibility and viscous effects in the classical approach is noted to be a major limiting factor in full-scale rotor applications of the classical vortex theory; it has nevertheless been valuable for the delineation of problem areas and the guiding of both experimental and theoretical investigations. O.C.

A92-25577
AEROELASTIC ANALYSIS OF SWEPT, ANHEDRAL, AND TAPERED TIP ROTOR BLADES
KI-CHUNG KIM and INDERJIT CHOPRA (Maryland, University, College Park) American Helicopter Society, Journal (ISSN 0002-8711), vol. 37, Jan. 1992, p. 15-30. refs
(Contract DAAL03-88-C-002)
Copyright
A systematic investigation of the effects of tip sweep, anhedral, and planform taper on helicopter rotor blade response and loads is conducted using comprehensive structural and aerodynamic models. A finite element methods is used for the structural analysis, and a three-dimensional (3D) finite difference aerodynamic analysis based on unsteady transonic small disturbance (TSD) theory is used to calculate the aerodynamic forces. The blade and its tip are treated as elastic beams undergoing flap bending, lag bending, elastic twist, and axial deflections. Nonlinear transformation relations based on moderate rotations are used to assemble the blade and tip elements. The blade response is calculated from nonlinear periodic normal mode equations using a finite element in time scheme. Vehicle trim and rotor elastic response are calculated as one coupled solution using a modified Newton method. Inclusion of nonlinear transformation relations between the tip and inboard blade is important for large tip angle (greater than 20 deg). Three-dimensional aerodynamic effects on blade lift distribution and bending moment are found to be quite significant for swept-tip and anhedral-tip blades. Author

A92-25636
A COMPARISON OF OPTIMIZATION-BASED APPROACHES FOR A MODEL COMPUTATIONAL AERODYNAMICS DESIGN PROBLEM
PAUL D. FRANK and GREGORY R. SHUBIN (Boeing Computer Services, Seattle, WA) Journal of Computational Physics (ISSN 0021-9991), vol. 98, Jan. 1992, p. 74-89. refs
Copyright
The Euler equations for 1D duct flow is presently used as the model problem in a robustness-efficiency-implementation difficulty comparison of three optimization-based aerodynamic design problem methods: (1) the 'black box' with finite-difference gradients; (2) a modification of the black box in which the gradients are ascertained by an implicit function theorem-based algorithm; and (3) simultaneous alteration of the flow and design variables. Method (2) is found to be a good compromise, as well as to be retrofittable to most existing analysis codes in order to transform them into design codes. Method (3) is the most efficient, but least robust. O.C.

A92-25676*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
LEWICE/E - AN EULER BASED ICE ACCRETION CODE
MARK G. POTAPCZUK (NASA, Lewis Research Center, Cleveland, OH) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 24 p. Previously announced in STAR as N92-14001. refs
(AIAA PAPER 92-0037) Copyright
A new version of the LEWICE ice accretion computer code was developed which calculates the ice growth on two dimensional surfaces, incorporating the effects of compressibility through the solution of the Euler equations. The code is modular and contains separate stand-alone program elements that create a grid, calculate the flow field parameters, calculate the droplet trajectory paths, determine the amount of ice growth, and plot results. This code increases the applicability of ice accretion predictions by allowing calculations at higher Mach numbers. The new elements of the code are described. Calculated results are compared to experiment for several cases, including a LEWICE example case and a thin airfoil section at a Mach number of 0.58. Author

A92-25677*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
PREDICTION OF ICE ACCRETION ON A SWEPT NACA 0012 AIRFOIL AND COMPARISONS TO FLIGHT TEST RESULTS
ANDREW L. REEHORST (NASA, Lewis Research Center, Cleveland, OH) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 59 p. Previously announced in STAR as N92-15968. refs
(AIAA PAPER 92-0043) Copyright
In the winter of 1989-90, an icing research flight project was conducted to obtain swept wing ice accretion data. Utilizing the NASA Lewis Research Center's DHC-6 DeHavilland Twin Otter aircraft, research flights were made into known icing conditions in Northeastern Ohio. The icing cloud environment and aircraft flight data were measured and recorded by an onboard data acquisition system. Upon entry into the icing environment, a 24 inch span, 15 inch chord NACA 0012 airfoil was extended from the aircraft and set to the desired sweep angle. After the growth of a well defined ice shape, the airfoil was retracted into the aircraft cabin for ice shape documentation. The ice accretions were recorded by ice tracings and photographs. Ice accretions were mostly of the glaze type and exhibited scalloping. The ice was accreted at sweep angles of 0, 30, and 45 degrees. A 3-D ice accretion prediction code was used to predict ice profiles for five selected flight test runs, which include sweep angle of zero, 30, and 45 degrees. The code's roughness input parameter was adjusted for best agreement. A simple procedure was added to the code to account for 3-D ice scalloping effects. The predicted ice profiles are compared to their respective flight test counterparts. This is the first attempt to predict ice profiles on swept wings with significant scalloped ice formations. Author

A92-25682*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
PRESSURE WAVE PROPAGATION STUDIES FOR OSCILLATING CASCADES
DENNIS L. HUFF (NASA, Lewis Research Center, Cleveland, OH) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 20 p. Previously announced in STAR as N92-15977. refs
(AIAA PAPER 92-0145) Copyright
The unsteady flowfield around an oscillating cascade of flat plates is studied using a time marching Euler code. Exact solutions based on linear theory serve as model problems to study pressure wave propagation in the numerical solution. The importance of using proper unsteady boundary conditions, grid resolution, and time step is demonstrated. Results show that an approximate non-reflecting boundary condition based on linear theory does a good job of minimizing reflections from the inflow and outflow boundaries and allows the placement of the boundaries to be closer than cases using reflective boundary conditions. Stretching the boundary to dampen the unsteady waves is another way to minimize reflections. Grid clustering near the plates does a better job of capturing the unsteady flowfield than cases using uniform grids as long as the CFL number is less than one for a sufficient portion of the grid. Results for various stagger angles and oscillation frequencies show good agreement with linear theory as long as the grid is properly resolved. Author

A92-25685*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
VARIABLE-COMPLEXITY AERODYNAMIC OPTIMIZATION OF AN HSCT WING USING STRUCTURAL WING-WEIGHT EQUATIONS
M. G. HUTCHISON, E. R. UNGER, W. H. MASON, B. GROSSMAN, and R. T. HAFTKA (Virginia Polytechnic Institute and State University, Blacksburg) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 19 p. refs
(Contract NAG1-1160; NSF DDM-90-08451)
(AIAA PAPER 92-0212) Copyright
A new approach for combining conceptual and preliminary design techniques for wing optimization is presented for the high-speed civil transport (HSCT). A wing-shape parametrization procedure is developed which allows the linking of planform and airfoil design variables. Variable-complexity design strategies are used to combine conceptual and preliminary-design approaches, both to preserve interdisciplinary design influences and to reduce computational expense. In the study, conceptual-design-level algebraic equations are used to estimate aircraft weight, supersonic wave drag, friction drag and drag due to lift. The drag due to lift and wave drag are also evaluated using more detailed, preliminary-design-level techniques. The methodology is applied to the minimization of the gross weight of an HSCT that flies at Mach 3.0 with a range of 6500 miles. Author

A92-25691#
AERODYNAMIC EFFECTS ON FUEL SPRAY STRUCTURE - EXPERIMENT AND THEORY
M. S. FAIRFIELD, T. D. BUTLER (Los Alamos National Laboratory, NM), C. PRESSER, A. K. GUPTA, and H. G. SEMERJIAN (NIST, Gaithersburg, MD) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 13 p. Research supported by DOE. refs
(AIAA PAPER 92-0227)
The effect of swirl on droplet transport processes is examined in a pressure-atomized, hollow-cone kerosene spray, introduced into coflowing nonswirling and swirling air flow fields. Both experimental and theoretical results for droplet mean diameter and velocity are presented and compared at several spatial positions in the near field region of the swirling spray. An ensemble light scattering/polarization ratio technique provided spatially resolved measurements on the local values of droplet mean size and number density in dense regions of the spray. Measurement of droplet size and velocity distributions were carried out using phase/Doppler interferometry. Laser velocimetry was also employed to measure the velocity distribution of the droplets and secondary air stream. The calculations were obtained using the KIVA-II computer code, which solves for the coupled motion of the spray droplets and turbulent air flow in two or three dimensional space. The results reveal that the introduction of swirl to the secondary air stream modifies the droplet/air velocity field in addition to the spatial distribution of the droplet size and number density. Author

A92-25723#
EXPERIMENTAL STUDIES OF A TWO-ELEMENT AIRFOIL WITH LARGE SEPARATION
KASIM BIBER and GLEN W. ZUMWALT (Wichita State University, KS) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 15 p. refs
(AIAA PAPER 92-0267) Copyright
Attention is given to an experimental program undertaken to study a two-element airfoil with moderate through large separation. The GA(W)-2 airfoil with 25-percent single-slotted flap was the test model at a Reynolds number of 2.2 x 10 exp 6 and Mach number of 0.13. Airfoil performance was studied through the measurements of aerodynamic forces and surface pressures. Flap-deflected configurations indicated a large degree of hysteresis with angle of attack changes. Flowfield static pressures were measured by a specially designed splitter plate and disk probe and presented by contours. The experimental program revealed the difficulty of measuring static pressures in separated flows. The presence of a probe, no matter how small, changes the flow geometry in the interacting parts of the flowfield. P.D.

A92-25725#
MODELING SUPERSONIC INLET BOUNDARY LAYER BLEED ROUGHNESS
GERALD C. PAYNTER, DAVID A. TREIBER, and W. D. KNEELING (Boeing Co., Seattle, WA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 29 p. refs
(AIAA PAPER 92-0269) Copyright
The rough-wall algebraic-turbulence model of Cebeci and Chang (1978) was added to both boundary-layer and Navier-Stokes analyses to simulate the overall effect of bleed on the growth of a boundary layer. This roughness model does not require a significant increase in the grid density. Roughness values were determined for selected experiments by varying a roughness parameter with either the boundary layer or the Navier-Stokes analysis until a match was obtained between predicted and measured boundary-layer velocity distributions downstream of a bleed region. Roughness values were determined for seven bleed configurations, a range of Mach numbers between 1.3 and 4, and bleed rates between zero and choked values. In several cases, bleed was used in the region of a shock/boundary-layer interaction. For the bleed experiments considered, the roughness was found to be a strong function of the fraction of the upstream boundary-layer mass flux removed: below a bleed rate of about 3 percent, the roughness was insignificant; for a bleed rate between 3 percent and 12 percent to 15 percent, high roughness values were found; and above a bleed rate of about 15 percent, the roughness was again found to be insignificant. Choked bleed flow through holes at a low angle with respect to the surface minimized the roughness effect and gave the best improvement in the boundary layer velocity distribution for separation control. Author

A92-25726*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
THREE-DIMENSIONAL SIMULATION OF A TRANSLATING STRUT INLET
D. J. SINGH (Analytical Services and Materials, Inc., Hampton, VA), CARL A. TREXLER (NASA, Langley Research Center, Hampton, VA), and JULIE A. HUDGENS (Analytical Services and Materials, Inc., Hampton, VA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 12 p. refs
(AIAA PAPER 92-0270)
A three-dimensional Navier-Stokes code is used to numerically simulate the flow through a translating strut scramjet inlet. The inlet has variable geometry for efficient operation over a wide speed range. Overall flow-field features such as the corner flow, topwall separation, shockwave coalescence, cowl pressure increase, and flow distortion at the throat are investigated. Comparisons are made with experimental results to provide for the assessment of the present analysis. Effects of boundary-layer ingestion on the overall flow features are also investigated. Author

A92-25727#
EVALUATION OF TWO FLOW ANALYSES FOR SUBSONIC DIFFUSER DESIGN
DAVID W. MAYER and W. D. KNEELING (Boeing Commercial Airplane Group, Seattle, WA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 13 p. refs
(AIAA PAPER 92-0273) Copyright
Progress toward the evaluation of a design-screening code and a Navier-Stokes code, under development to support the flow analysis and design of subsonic diffusers, is reported by means of a comparison with a representative diffuser experiment. The experiment is a rectangular diffuser flow, near separation, with a curved upper wall, a flat lower wall, and parallel sidewalls. It is found that the ability of the codes to predict separation must still be determined since it was unclear from the experiment if boundary layer separation occurred. Predicted wall pressure distributions with both codes were in acceptable agreement with the measured

values. Predicted mass flux distributions were in acceptable agreement with the test data given the need to estimate some of the upstream flow conditions. The two codes agreed to within 1 percent on the area-averaged stagnation pressure recovery at the diffuser. P.D.

A92-25728*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

ANALYSIS OF AN ADVANCED DUCTED PROPELLER SUBSONIC INLET

CHANTHY IEK, DONALD R. BOLDMAN (NASA, Lewis Research Center, Cleveland, OH), and MOUNIR IBRAHIM (Cleveland State University, OH) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 17 p. Previously announced in STAR as N92-14002. refs

(AIAA PAPER 92-0274) Copyright

It is shown that a time marching Navier-Stokes code called PARC can be utilized to provide a reasonable prediction of the flow field within an inlet for an advanced ducted propeller. The code validation was implemented for a nonseparated flow condition associated with the inlet functioning at angles-of-attack of zero and 25 deg. Comparison of the computational results with the test data shows that the PARC code with the propeller face fixed flow properties boundary conditions (BC) provided a better prediction of the inlet surface static pressures than the prediction when the mass flow BC was employed. R.E.P.

A92-25729#

CONTROLLING UNSTEADY LIFT USING UNSTEADY TRAILING-EDGE FLAP MOTIONS

RONALD J. HUGO and ERIC J. JUMPER (Notre Dame, University, IN) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 9 p. Research supported by McDonnell Douglas Corp. refs

(AIAA PAPER 92-0275) Copyright

An investigation of the unsteady, inviscid, incompressible, two-dimensional flow over an airfoil executing unsteady motions has been conducted. Accurate formulations characterizing the unsteady lift due to trailing-edge flap deflections have been developed. The unsteady lift equation for trailing-edge flap motions is incorporated into a simple, real time lift-control algorithm. The algorithm has been applied to a variety of problems, including ramp (constant pitch rate) motions and oscillating angle of attack motions. A simulated 'gust' or unsteady vortical disturbance problem, which involved a discrete convecting vortex, was also treated by the algorithm. In all cases the algorithm was found to perform well as a robust theoretical formulation for unsteady lift control. Author

A92-25730#

UNIQUE HIGH-ALPHA ROLL DYNAMICS OF A SHARP-EDGED 65 DEG DELTA WING

L. E. ERICSSON (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) and E. S. HANFF (Institute of Aerospace Research, Ottawa, Canada) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 13 p. refs

(AIAA PAPER 92-0276) Copyright

An analysis has been performed of experimental results obtained in roll oscillation tests at 30 deg angle of attack of a 65 deg sharp-edged delta wing in order to uncover the fluid mechanical phenomena causing the unusual, highly nonlinear vehicle dynamics. In addition to the expected effect of convective flow time lag the test results show highly nonlinear effects of the oscillatory rate, which themselves are influenced by the effect of convective time lag. A hypothesis is presented that can explain the unusual experimental results. Author

A92-25731*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

UNSTEADY WING SURFACE PRESSURES IN THE WAKE OF A PROPELLER

R. T. JOHNSTON and J. P. SULLIVAN (Purdue University, West Lafayette, IN) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 12 p. Research supported by NASA. refs

(AIAA PAPER 92-0277) Copyright

The unsteady nature of the propeller slipstream interacting with a wing has been studied by flow visualization and unsteady wing surface pressure measurements. Flow visualization was performed by marking the propeller tip vortex with smoke. Unsteady wing surface pressures were measured by traversing a wing instrumented with a chordwise array of 16 microphones in a spanwise direction through the propeller wake. This work yielded information on the motion of the propeller wake as it passes over the wing. As the propeller wake passed over the wing: the propeller tip vortex experienced an inviscid interaction at the leading edge; viscous action at the leading edge severed the propeller tip vortex; the propeller tip vortex experienced significant spanwise and chordwise displacements and then deformed in order to reconnect at the trailing edge; axial velocity in the vortex core caused the helical vortex to thicken or stretch near the wing surface; and, the magnitude of the pressure fluctuations decreased in magnitude with distance traveled along the chord. Author

A92-25732#

PITCH-UP MOTIONS OF DELTA WINGS

O. K. REDINIOTIS, S. M. KLUTE, N. T. HOANG, and D. P. TELIONIS (Virginia Polytechnic Institute and State University, Blacksburg) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 10 p. refs

(Contract AF-AFOSR-91-0310)

(AIAA PAPER 92-0278) Copyright

The transient flow field over a delta wing during pitch-up motions to very large angles of attack was investigated. Emphasis was directed at the growth and the eventual breakdown of leading edge vortices. Delta wing models were tested in a wind tunnel at Reynolds number of order 10 exp 5. Instantaneous pressure measurements were obtained, while the flow field was mapped out via a seven-hole probe designed, constructed, and calibrated to generate time-varying information. Earlier qualitative evidence of hysteresis in the development of the flow was confirmed. Moreover, the present data indicate significant differences of vorticity content between the steady and the unsteady motions. Author

A92-25734*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

THREE-DIMENSIONAL SIMULATION OF SLENDER DELTA WING ROCK AND DIVERGENCE

OSAMA A. KANDIL and AHMED A. SALMAN (Old Dominion University, Norfolk, VA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 12 p. refs

(Contract NAG1-648)

(AIAA PAPER 92-0280) Copyright

Computational simulation of three-dimensional flows around a delta wing undergoing rock and roll-divergence motions is presented. The problem is a multidisciplinary one where fluid-dynamics equations and rigid-body-dynamics equations are sequentially solved. For the fluid-dynamics part, the unsteady Euler equations, which are written relative to a moving frame of reference, are solved using an implicit, approximately-factored, central-difference, finite-volume scheme. For the rigid-body dynamics part, the Euler equation of rigid-body rolling motion is solved using a four-stage Runge-Kutta scheme. Since the applications do not include deforming wings or relative-rigid-body motions, the computational-fluid-dynamics grid, which is fixed in the moving frame of reference, does not need to be updated once it is generated. Author

A92-25735#

THE EVALUATION OF CANARD COUPLINGS AT HIGH ANGLES OF ATTACK

A. J. PONTON, M. V. LOWSON, and R. V. BARRETT (Bristol, University, England) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 20 p. Research supported

by Defence Research Agency. refs
(AIAA PAPER 92-0281) Copyright
Experiments have been performed on the vortex flows over a generic canard fighter aircraft model at high angles of attack to identify the conditions under which favorable and unfavorable interferences occur. Favorable canard interactions have been found to be strongly related to canard downwash and to the state of the vortex flows over the main wing. Direct vortex impingement leads to unfavorable interference, though some vortex interactions were found to be advantageous for a limited range of incidence and canard deflection angles. Clear trends in performance with canard mounting position relative to the wing have been found. The optimum canard position is connected with the delivery of the canard downwash onto the wing, and the degree of unfavorable vortex interaction present. Higher canard mounting positions in front and above the main wing are thus preferable. The flow structures observed were highly complex, with interactions between the fuselage, canard, and wing flowfields. The fundamental mechanisms of these vortex flows have been studied. Author

A92-25736#
CALCULATION OF THE CARRIAGE LOADS OF TANDEM STORES ON A FIGHTER AIRCRAFT
R. H. NICHOLS, J. L. JACOCKS, and M. J. RIST (Calspan Corp., Arnold AFB, TN) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 19 p. refs
(AIAA PAPER 92-0283)
Computation of the flowfield about an F-15E aircraft with a tandem store configuration at a Mach number of 0.98 has been completed. The Euler equations were solved to calculate the flow around all aircraft components and stores with the exception of the tandem stores. The tandem stores and the inboard store were calculated initially with the Euler equations and subsequently with the Navier-Stokes equations incorporating a two-equation turbulence model. Carriage loads for the stores predicted with the Euler equations differ significantly from those calculated with the Navier-Stokes equations and those measured in wind tunnel tests. Carriage loads for the aft tandem store predicted with the Navier-Stokes equations are in good agreement with experiment. The proper trends in the aft store trajectory were predicted with both the Euler and Navier-Stokes flowfields. Author

A92-25737#
PREDICTION OF AVERAGE DOWNWASH GRADIENT FOR CANARD CONFIGURATIONS
DAVID W. LEVY (Michigan, University, Ann Arbor) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 21 p. refs
(AIAA PAPER 92-0284) Copyright
Design charts are presented which give correction factors to account for the nonlinear variation of downwash gradient induced by a canard across the span of the main wing. The correction factors are derived using the vortex lattice computational method to calculate the induced velocities behind the canard. Data are presented for a variety of relative positions and canard geometry. The method is valid for incompressible flow and for geometries where the canard wake does not impinge on the main wing. Comparisons with existing methods and results for canard/wing combinations indicate the method is accurate enough for conceptual and preliminary phases of the design of airplanes with canards. Author

A92-25738#
NON-PLANAR WING DESIGN BY NAVIER-STOKES INVERSE COMPUTATION
T. KAIDEN, J. OGINO (Mitsubishi Heavy Industries, Ltd., Nagoya, Japan), and S. TAKANASHI (National Aerospace Laboratory, Tokyo, Japan) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 9 p. refs
(AIAA PAPER 92-0285) Copyright
A three-dimensional transonic nonplanar wing aerodynamic design method is developed by combining Navier-Stokes analysis code with existing inverse code. The inverse code is based on small disturbance equation. The present method is an iterative procedure of the Navier-Stokes analysis code and the inverse code. Transonic nonplanar wing is designed for H-II Orbiting Plane (HOPE) tipfin configuration by using the present method. Such a huge tipfin, wing and body create complicated corner flow and associated separation so that it is difficult to design nonplanar wing by using conventional full potential analysis without considering the viscous effect. Navier-Stokes analysis makes it possible to design it and solve aerodynamic problems. Therefore, the method is proved to be an effective tool in aerodynamic design about a nonplanar wing. Author

A92-25739#
AN APPROACH TO THE DESIGN OF WINGS - THE ROLE OF MATHEMATICS, PHYSICS AND ECONOMICS
T. CEBECI, A. A. KHATTAB, H. H. CHEN, and L. T. CHEN (California State University, Long Beach) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 16 p. refs
(AIAA PAPER 92-0286) Copyright
An interactive boundary-layer method and a transition method are described for computing 3D transonic flows on wing and wing/body configurations. The interactive method combines Euler solutions with viscous flow solutions obtained from an inverse boundary layer method that is based on the extension of the Hilbert integral formulation used for 2D flows. The transition method makes use of the e-super-n-method based on the solutions of the linear stability equations with an eigenvalue formulation based on the saddle-point method. Calculations performed with the interactive method show good agreement with experimental data at substantial savings of computer time. These calculations also indicate that analysis of wing/body configurations with strong body effects require Euler methods that employ cell-centered schemes rather than cell-vertex schemes. Author

A92-25740#
EFFECT OF VISCOUS DRAG ON OPTIMUM SPANWISE LIFT DISTRIBUTION
KAMRAN ROKHSAZ (Wichita State University, KS) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 5 p. refs
(AIAA PAPER 92-0287) Copyright
It is demonstrated that the classical lifting line theory can be modified for the effect of viscous drag. The process is shown, primarily through an example, employing a rectangular wing made of an NACA symmetric airfoil. Rapid convergence of the resulting series is demonstrated. It is shown that the inclusion of viscous drag indeed renders the elliptic lift distribution nonoptimal. However, in every case, the reduction in viscous drag is very closely matched by an increase in induced drag. Therefore, the reduction in total drag, within the confines of this theory, is determined to be negligible. Author

A92-25748#
A DATA BASE FOR FLIGHT IN THE WAKE OF A SHIP
J. V. HEALEY (U.S. Naval Postgraduate School, Monterey, CA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 22 p. Research supported by U.S. Navy. refs
(AIAA PAPER 92-0295) Copyright
The NASA Ames 'Shipboard Simulator' appears to have been the only serious attempt to model flight in the wake of a structure. This simulator is based on a faulty airwake data base that was established with a uniform velocity profile and very low turbulence. The present study attempts to correct this situation by making 3D hot-wire anemometer measurements of the airwake properties of a stationary 1/141 scale model ship in a simulated atmospheric boundary layer. The measurements included velocities, turbulence intensities and spectra, at seventeen points along typical helicopter glide paths, within one ship-length of the touchdown location. These data provide a preliminary single-point data base for simulation of helicopter flight in the wake of the real ship. The results for one path only are presented. In general, the velocities and the root-mean-square values of their fluctuations decrease as the ship

approached. No correlation is found with the data base in the NASA simulator. There is some doubt about the accuracy of certain measurements close to the ship because of very low mean velocities. Author

A92-25754#

HYPERSONIC WAVERIDERS - EFFECTS OF CHEMICALLY REACTING FLOW AND VISCOUS INTERACTION

JOHN D. ANDERSON, JR., JINHWA CHANG, and THOMAS A. MCLAUGHLIN (Maryland, University, College Park) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 13 p. refs

(AIAA PAPER 92-0302) Copyright

Effects of chemically reacting flow and classic hypersonic viscous interaction on waverider performance and design are discussed. Two families of viscous optimized waveriders under consideration include a family designed on the basis of a chemically reacting inviscid flowfield and a family wherein viscous interaction effects are included within the optimization process. It is concluded that the effects of chemically reacting flow on the inviscid aspects of waverider flowfields are insignificant for Mach numbers of practical interest. High temperature effects within the boundary layer may be significant. It is expected that viscous interaction effects will be important for any slender hypersonic vehicle flying at high Mach number at high altitudes. O.G.

A92-25755*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

AERODYNAMIC CHARACTERISTICS OF A HYPERSONIC VISCOUS OPTIMIZED WAVERIDER AT HIGH ALTITUDES

DIDIER F. G. RAULT (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 19 p. refs

(AIAA PAPER 92-0306) Copyright

The present paper addresses the applicability of the basic concept of waveriding at high altitudes, and the extent to which the large viscous forces degrade the aerodynamic performance of waveriders. The waverider under consideration was designed using a continuum flow methodology. It is shown that the lift-to-drag ratio of high-altitude/high-Knudsen-number waveriders can be expected to be significantly lower than their low altitude/low Knudsen number counterparts. The aerodynamic performance of a representative waverider which was optimized for a 90-km, Mach-25 application is studied for altitudes ranging from 97 km to 145 km and incidence angles of 0 to 30 deg. Typical values of the lift-to-drag ratio were computed to be in the range of 0 to 0.3. Friction forces are mostly responsible for this poor performance. Friction forces account for more than 93 percent of the drag and significantly reduce lift. C.A.B.

A92-25757#

THE EFFECT OF SUCCESSIVE DISTORTIONS OF THE BOUNDARY LAYER IN A SUPERSONIC FLOW

DOUGLAS R. SMITH and ALEXANDER J. SMITS (Princeton University, NJ) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 12 p. refs

(Contract AF-AFOSR-90-0261)

(AIAA PAPER 92-0309) Copyright

An experiment was performed to investigate the combined effects of two distortions on a boundary layer in a supersonic flow. The boundary layer was investigated downstream of a step where the step was created by a 20-deg compression corner followed by a 20-deg expansion corner. A region 12 delta 0 long extended downstream of the step for flow relaxation. In this relaxation region, the mean flow and turbulence behavior of the boundary layer were measured. The mean velocity profile was found to be altered by the distortion. Recovery of the profile began near the wall and occurred rapidly, but in the outer part of the boundary layer, recovery proceeded slowly. Turbulence measurements revealed a dramatic reduction in the turbulence shear stress and a progressively decaying streamwise Reynolds stress profile. Author

A92-25758#

A THREE-DIMENSIONAL SUPERSONIC TURBULENT BOUNDARY LAYER GENERATED BY AN ISENTROPIC COMPRESSION

W. KONRAD, A. J. SMITS (Princeton University, NJ), and D. KNIGHT (Rutgers University, New Brunswick, NJ) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 12 p. refs

(Contract AF-AFOSR-89-0033; AF-AFOSR-86-0266)

(AIAA PAPER 92-0310) Copyright

Presented are the results of a combined experimental and theoretical study of a three-dimensional supersonic turbulent boundary layer. The three-dimensionality is introduced by an isentropic 20 degree compression in contrast to the more usual shock-generated compression, as in sharp fin interactions. Experimental data taken thus far include the surface pressure field, surface flow visualization, and, for selected locations, yaw angle, Pitot pressure, and static pressure. Comparisons with computational results show encouraging agreement. Author

A92-25759*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

AN ALGEBRAIC MODEL FOR DISSIPATION IN SUPERSONIC BOUNDARY LAYERS

J. HE, J. Y. KAZAKIA, A. I. RUBAN, and J. D. A. WALKER (Lehigh University, Bethlehem, PA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 14 p. Research supported by United Technologies Corp. refs

(Contract NAG1-832; AF-AFOSR-89-0487)

(AIAA PAPER 92-0311) Copyright

With increasing mainstream Mach number, viscous dissipation becomes a progressively important influence in high-speed compressible turbulent boundary layers. An asymptotic analysis is carried out for high Reynolds numbers and Mach numbers of order 1, and it is shown that viscous dissipation gives rise to important terms in the solution of the total enthalpy equation. For simplicity, the case of supersonic flow over an adiabatic wall is considered. An expression for the adiabatic wall temperature is derived. It is shown that the asymptotic analysis constrains the types of turbulence models that can be used to represent the effects of viscous dissipation. A simple algebraic turbulence model is proposed and comparisons with measured total enthalpy profile data show good agreement. Author

A92-25761#

TURBULENCE AMPLIFICATION THROUGH A SHOCK WAVE

DAVID NIXON, LAURENCE R. KEEFE, and LAURA C. RODMAN (Nielsen Engineering and Research, Inc., Mountain View, CA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 12 p. refs

(AIAA PAPER 92-0313) Copyright

A simple theory for the effect of a shock wave on turbulence is described. Equations relating normal and tangential velocities ahead of and behind the shock are derived to describe the generation of turbulent kinetic energy by the shock. These equations can also be used to identify the shock-induced enhancement or attenuation of the various turbulence scales. These relations explain the role of the shock speed and ripple in turbulence enhancement, and indicate a means of controlling the enhancement. It is concluded that the shock speed and ripple are not only critical terms in the production of turbulent kinetic energy, but are responsible for the amplification or attenuation of specific turbulence scales. O.G.

A92-25762*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

EXPERIMENTS ON SHOCK/VORTEX INTERACTIONS

L. N. CATTAFESTA, III and G. S. SETTLES (Pennsylvania State University, University Park) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 13 p. refs

(Contract NAG2-575)

(AIAA PAPER 92-0315) Copyright

The interaction between a shock wave and a supersonic

streamwise vortex is a fundamental fluid-dynamics problem with numerous practical applications. This paper describes an experimental study of this phenomenon. In particular, supersonic streamwise vortices of varying strength and Mach number were generated and measured using five-hole and total-temperature probes. In addition, the interactions between a vortex and either an oblique or a normal shock wave were visualized using schlieren and planar-laser-scattering techniques. The mean-flow measurements show both similarities and differences between the supersonic streamwise vortex and its incompressible counterpart, while the flow-visualization results show that the shock/vortex interaction is always unsteady and that, under certain conditions, the vortex can burst. The conditions necessary for supersonic vortex breakdown are presented. Author

A92-25763#
AN ANALYTICAL AND COMPUTATIONAL INVESTIGATION OF SHOCK-INDUCED VORTICAL FLOWS
JOSEPH YANG, TOSHI KUBOTA, and EDWARD E. ZUKOSKI (California Institute of Technology, Pasadena) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 14 p. refs
(Contract F49620-86-C-0113; AF-AFOSR-90-0188)
(AIAA PAPER 92-0316) Copyright

The shock-induced vortical flow has been investigated computationally by solving a canonical problem for the 2D unsteady interaction in a finite channel. The dynamics of the vortex pair is controlled by the incident shock strength, the light/heavy gas density ratio, and the channel spacing. Analytical expressions are derived, where the strength and motion of the vortex pair is described as a function of these parameters. The mixing of shock-induced vortical flows is characterized for both single jet shape perturbations and multiple jet geometrical variations. An analogy to the corresponding 3D steady flows is demonstrated both qualitatively and quantitatively. An understanding of the dynamics and mixing of the 2D, unsteady flows can be directly applied to 3D, steady flows typical of scramjet designs. O.G.

A92-25764#
FLOW VISUALIZATION IMAGE ANALYSIS OF HIGH-RATE ROLL EXPERIMENTS ON A DELTA WING
ERIC J. STEPHEN, THOMAS E. MCLAUGHLIN, and MARVIN W. LUTTGES (Colorado, University, Boulder) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 19 p. refs
(AIAA PAPER 92-0317)

Vortical flow near a delta wing oscillating in roll was analyzed using digital image analysis techniques. High speed video flow visualization data obtained from wind tunnel tests were first digitized and stored for analysis. Vortex size, position and coherence were recorded as a function of mean roll angle, roll amplitude, phase angle and chord position. Preliminary results indicate that flow structure is dependent upon the instantaneous position of the delta wing relative to the freestream velocity vector. Hysteresis was observed in the initiation and development of vortical formations. Flow development was strongly dependent on the time scales associated with vortex roll up. Author

A92-25765#
THE ANCHORED AND LOOSE VORTEX SYSTEMS OF FINITE WINGS
PETER FREYMUTH (Colorado, University, Boulder) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 9 p. refs
(AIAA PAPER 92-0318) Copyright

The primary vortex structures over small, planar wings with a variety of planforms (triangular, trapezoidal, round) have been visualized in the low and high angle of attack steady flight modes. The low angle of attack mode is characterized by the anchoring of the vortex system on the wing surface and by tip vortices. The high angle of attack mode is characterized by loss of anchoring and by obliteration of the tip vortices. The limits of the visualization method will be pointed out. Author

A92-25766#
AN EXPERIMENTAL AND ANALYTICAL STUDY OF THE INTERACTION OF A VORTEX WITH AN AIRFRAME
H. AFFES, A. T. CONLISK (Ohio State University, Columbus), J. M. KIM, and N. M. KOMERATH (Georgia Institute of Technology, Atlanta) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 12 p. refs
(Contract DAAL03-88-C-0003)
(AIAA PAPER 92-0319) Copyright

The behavior of vortex systems in the vicinity of solid surfaces is a matter of intense interest in rotorcraft aerodynamics, as well as in many others areas of fluid dynamics. Vortex-surface interactions on rotorcraft are complex and involve a variety of time and length scales along with very strong viscous effects; consequently, a good physical understanding of the phenomena in a simpler geometry advanced by a combined analytical, computational and experimental approach is necessary for improving methods for computing flows around more complex configurations. The purpose of the present paper is to present experimental and analytical results for the interaction of a rotor tip vortex filament with an airframe. In particular, results are presented for the vortex trajectory and pressure distribution on the airframe. The experimental and analytical/numerical results are in substantial agreement prior to the impact of the vortex with the airframe. Author

A92-25767#
A SIMPLIFIED MODEL FOR THE INTERACTION OF A ROTOR TIP VORTEX WITH AN AIRFRAME
H. AFFES and A. T. CONLISK (Ohio State University, Columbus) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 17 p. Research sponsored by U.S. Army. refs
(AIAA PAPER 92-0320) Copyright

A simplified model for the interaction of a rotor tip vortex with the helicopter fuselage is developed. The effect of mean flow, vortex core size, and the relative magnitude of mean downwash and mean axial flow on the evolution of the vortex are considered. Numerical calculations indicate that the motion of the filament induces a very strong axial adverse pressure gradient on the cylinder under the filament, which results in a strong negative pressure spike. The curvature of the vortex filament appears to remain finite as the filament approaches the cylinder, and no kinks arise in the filament profile. It is suggested that the vortex core flow will deviate substantially from the axisymmetric solution assumed as the vortex approaches the airframe. O.G.

A92-25768#
EULER CALCULATIONS OF AXISYMMETRIC UNDER-EXPANDED JETS BY AN ADAPTIVE-REFINEMENT METHOD
DARREN DE ZEEUW and KENNETH G. POWELL (Michigan, University, Ann Arbor) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 14 p. refs
(AIAA PAPER 92-0321) Copyright

Under-expanded jet flows are calculated using an adaptive-refinement solution method for the axisymmetric Euler equations. The solution procedure is tree-based, and flux-vector splitting and a positive, linear reconstruction method are used. The refinement criterion, based on the divergence and curl of the local velocity, is shown to capture the flow features adequately. Results are presented for a range of jet-to-stream total pressure ratios, and for two jet Mach numbers. The resulting flows show a complex shock-shear-expansion structure, with Mach disks forming at high jet-to-stream pressure ratios. The location of the Mach disk is shown to be sensitive to the jet Mach number. Author

A92-25769#
A WAVE-MODEL-BASED REFINEMENT CRITERION FOR ADAPTIVE-GRID COMPUTATION OF COMPRESSIBLE FLOWS
HENRI PAILLERE, KENNETH G. POWELL, and DARREN DE ZEEUW (Michigan, University, Ann Arbor) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 11

p. refs
(AIAA PAPER 92-0322) Copyright
A criterion for adaptive mesh refinement for compressible-flow calculations is presented. The criterion is based on a two-dimensional wave-model for the Euler equations, and can separately detect regions in which acoustic waves are important, and regions in which shear waves are important. This ability to detect regions of compressibility and rotationality separately gives better resolution of features of disparate strength. Results for representative test cases are presented, and compared to results from a grid-aligned wave-model-based criterion, and more classical criteria, such as undivided differences of pressure or density.
Author

A92-25770#
AN EFFICIENT EULER SOLVER FOR PREDOMINANTLY SUPERSONIC FLOWS WITH EMBEDDED SUBSONIC POCKETS
C. B. ALLEN and S. P. FIDDES (Bristol, University, England) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 10 p. refs
(AIAA PAPER 92-0323) Copyright
A hybrid Euler solver is presented that exploits the efficiency of space-marching in supersonic regions of the flow, but reverts to an iterative time-marching scheme if a subsonic region is encountered. Independent time-marching and space-marching schemes are described, along with a simple technique to switch between the two. Particular attention is given to the implementation of boundary conditions in the final method to give a simple scheme which can be applied to any geometry and Mach number. A time-marching scheme is shown based on a first-order discretization with Van-Leer's flux-vector splitting, and a space-marching scheme based on S.F. Wornom's two-point cell-vertex method. Both use line relaxation to solve the resulting finite volume equations. Results are shown for hypersonic intake flow, transonic channel flow, hypersonic channel flow with an embedded subsonic pocket and supersonic blunt body flow. The accuracy and efficiency of the hybrid scheme is clearly demonstrated along with its ease of use.
Author

A92-25771*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
MULTIDOMAIN SPECTRAL SOLUTIONS OF HIGH-SPEED FLOWS OVER BLUNT CONES
DAVID A. KOPRIVA (Florida State University, Tallahassee) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 10 p. refs
(Contract NAG1-862; DE-FC05-85ER-25000)
(AIAA PAPER 92-0324) Copyright
A shock-fitted multidomain spectral collocation method is used to solve steady inviscid supersonic flows over two blunt, axisymmetric cones. The calculations are compared to a conical flow solution and to experimental data.
Author

A92-25772*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A NEARLY-MONOTONE GENUINELY MULTIDIMENSIONAL SCHEME FOR THE EULER EQUATIONS
IJAZ H. PARPIA and DONNA J. MICHALEK (Texas, University, Arlington) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 9 p. refs
(Contract NAG1-1207)
(AIAA PAPER 92-0325) Copyright
Recent progress made in the development of a genuinely multidimensional finite-volume method for the Euler equations is reported. In this method, wave information is derived from a reconstruction procedure applied to the data on a triangle. The algorithm is therefore best suited to application on an unstructured grid. A flux formula which provides nearly-monotone solutions is also presented. The new method is tested on three simple 2D flows, and the results show that dominant-wave resolution is high, and that strong-wave transitions are nearly monotone.
Author

A92-25775# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
A BALLISTIC INVESTIGATION OF THE AERODYNAMIC CHARACTERISTICS OF A BLUNT VEHICLE AT HYPERSONIC SPEEDS IN CARBON DIOXIDE AND AIR
JAMES D. PACKARD, WAYLAND C. GRIFFITH (North Carolina State University, Raleigh), LESLIE A. YATES (Eloret Institute, Palo Alto, CA), and ANTHONY W. STRAWA (NASA, Ames Research Center, Moffett Field, CA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 12 p. refs
(Contract NAGW-1331; NCA2-417)
(AIAA PAPER 92-0328) Copyright
Missions to Mars require the successful development of aerobraking technology, and therefore a blunt cone representative of aerobrake shapes is investigated. Ballistic tests of the Pioneer Venus configuration are conducted in carbon dioxide and air at Mach numbers from 7 to 20 and Reynolds numbers from 0.1 x 10 exp 5 to 4 x 10 exp 6. Experimental results show that for defined conditions aerodynamic research can be conducted in air rather than carbon dioxide, providing savings in time and money. In addition, the results offer a prediction of flight aerodynamics during entry into the Martian atmosphere. Also discussed is a comparison of results from two data-reduction techniques showing that a five-degree-of-freedom routine employing weighted least-squares with differential corrections analyzes ballistic data more accurately.
Author

A92-25777*# National Aeronautics and Space Administration, Washington, DC.
ANALYSIS OF HYPERSONIC NOZZLES INCLUDING VIBRATIONAL NONEQUILIBRIUM AND INTERMOLECULAR FORCE EFFECTS
PATRICK W. CANUPP, GRAHAM V. CANDLER, JOHN N. PERKINS, and WAYNE D. ERICKSON (North Carolina State University, Raleigh) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 11 p. Research supported by North Carolina Space Grant Consortium. refs
(Contract NAGW-1331)
(AIAA PAPER 92-0330) Copyright
A computational fluid dynamics algorithm is developed for the study of high-pressure axisymmetric hypersonic nozzle flows. The effects of intermolecular forces and vibrational nonequilibrium are included in the analysis. The numerical simulation of gases with an arbitrary equation of state is discussed. Simulations for a high pressure nozzle (p(0) = 138 MPa) demonstrate that both intermolecular forces and vibrational nonequilibrium have a significant affect on the flow. These nonideal effects tend to increase the Mach number at the nozzle exit plane. Thus, they must be included in the design and analysis of high pressure hypersonic nozzles.
Author

A92-25779*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AERODYNAMIC DESIGN OF AXISYMMETRIC HYPERSONIC WIND-TUNNEL NOZZLES USING LEAST-SQUARES/PARABOLIZED NAVIER-STOKES PROCEDURE
JOHN J. KORTE (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 11 p. refs
(AIAA PAPER 92-0332) Copyright
A new procedure unifying the best of present classical design practices, CFD and optimization procedures, is demonstrated for designing the aerodynamic lines of hypersonic wind tunnel nozzles. This procedure can be employed to design hypersonic wind tunnel nozzles with thick boundary layers where the classical design procedure has been demonstrated to break down. Advantages of this procedure allow full utilization of powerful CFD codes in the design process, solves an optimization problem to determine the new contour, may be used to design new nozzles or improve sections of existing nozzles, and automatically compensates the nozzle contour for viscous effects as part of the unified design procedure.
R.E.P.

A92-26216* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
HYPERSONIC FLOW SIMULATIONS USING DSMC (DIRECT SIMULATION MONTE CARLO)
JAMES N. MOSS (NASA, Langley Research Center, Hampton, VA) IN: Computing methods in applied sciences and engineering; Proceedings of the 9th International Conference, Paris, France, Jan. 29-Feb. 2, 1990. Philadelphia, PA, Society for Industrial and Applied Mathematics, 1990, p. 160-179. refs
Copyright
A review of the DSMC method of Bird is presented. The DSMC method provides the capability of simulating real gas flows in the rarefied flow regime. Recent developments and applications of the method for hypersonic flows are reported for both ground-based tests and during entry. Results obtained using both axisymmetric and 3D codes are included. Author

A92-26240#
MEASUREMENT OF A THREE-DIMENSIONAL HYPERSONIC DENSITY FIELD
STEVE DOERR (Ktech Corp., Albuquerque, NM) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 12 p. refs
(AIAA PAPER 92-0383) Copyright
A holographic interferometry system was developed to gain insight into the physics of the flow about a generic maneuvering reentry vehicle in a hypersonic wind tunnel. A dual-plate micropositioner and a digital phase detection technique were used to resolve phase values from the interferograms. Reconstruction of the interferometric data was accomplished using an algebraic reconstruction technique to solve the ill-posed, linear set of equations that result from a series expansion approximation of the density field. The measured data and flow visualization photographs document an extensive separation region that was not indicated in the computations. Holographic interferometry was shown to be a viable technique for acquiring the data needed to reconstruct three-dimensional (3D) density fields in a hypersonic wind tunnel. Author

A92-26241*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FLOW FIELD MEASUREMENT AND VISUALIZATION USING PROJECTED SMOKE TRAILS
J. S. STEINHOFF and T. MERSCH (Tennessee, University, Tullahoma) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 11 p. Research supported by Rheinisch-Westfaelische Technische Hochschule Aachen. refs
(Contract NAG1-560)
(AIAA PAPER 92-0384) Copyright
A new, simple method is described for measuring and visualizing air flows. The method involves projecting a small heated metal pellet through the air at a speed greater than the flow. The pellet burns as it moves through the air and leaves a wake of very fine, visible, metal oxide particles. The position of this visible smoke trail is then photographed at a sequence of times. The displacement of the trail can be used to provide a plot of the normal component of velocity as a function of distance. Examples are given for very low speed thermal convection (less than about 1 m/sec) and low speed flow over airfoils and cylinders (less than about 10 m/sec). Comparisons of the method to pulsed smoke-wire, spark-tracer and laser fluorescence methods, which give similar information, are discussed. Author

A92-26242#
FLOW VISUALIZATION OF A PROP-FAN LEADING-EDGE VORTEX
J. C. SIMONICH, D. C. MCCORMICK, and R. J. HAAS (United Technologies Research Center, East Hartford, CT) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 15 p. Research supported by United Technologies Corp. refs
(AIAA PAPER 92-0386) Copyright
An experimental study of the flow-field of a prop-fan has been carried out using flow visualization techniques. Particular attention was focused on the leading-edge vortex, since it is one of the mechanisms responsible for interaction noise in counter-rotating prop-fans. Two different prop-fan configurations were tested: conventional aft-sweep and forward-sweep. A new technique which utilizes injection of smoke in the rotating reference frame of the blades was applied to prop-fan for the first time. By the use of this technique, the height of the leading-edge vortex on a prop-fan could be determined. A back-to-back comparison between oil surface flow and fluorescent mini-tuft visualization was performed. Author

A92-26243*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
SINGLE EXPANSION RAMP NOZZLE SIMULATIONS
STEPHEN M. RUFFIN (NASA, Ames Research Center, Moffett Field, CA), ETHIRAJ VENKATAPATHY, SEUNG-HO LEE, EARL R. KEENER (Eloret Institute, Palo Alto, CA), and FRANK W. SPAID (McDonnell Douglas Research Laboratories, Saint Louis, MO) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 12 p. refs
(AIAA PAPER 92-0387) Copyright
The single-expansion-ramp-nozzle (SERN) experiment underway at NASA Ames Research Center simulates the National Aerospace Plane propulsive jet-plume flow. Recently, limited experimental data has become available from an experiment with a generic nozzle/afterbody model in a hypersonic wind tunnel. The present paper presents full three-dimensional solutions obtained with the implicit Navier-Stokes solver, FL3D, for the baseline model and a version of the model with side extensions. Analysis of the computed flow clearly shows the complex 3-D nature of the flow, critical flow features, and the effect of side extensions on the plume flow development. Flow schematics appropriate for the conditions tested are presented for the baseline model and the model with side extensions. The computed results show excellent agreement with experimental shadowgraph and with surface pressure measurements. The computed and experimental surface oil-flows show the same features but may be improved by appropriate turbulence modeling. Author

A92-26244*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AERODYNAMIC CHARACTERISTICS OF A PROPELLER POWERED HIGH LIFT SEMISPAN WING
M. A. TAKALLU (Lockheed Engineering and Sciences Co., Hampton, VA) and G. L. GENTRY, JR. (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 13 p. refs
(AIAA PAPER 92-0388) Copyright
An experimental investigation was conducted on the engine/airframe integration aerodynamics for potential high-lift aircraft configurations. The model consisted of a semispan wing with a double-isolated flap system and a Krueger leading edge device. The advanced propeller and the powered nacelle were tested and aerodynamic characteristics of the combined system are presented. It was found that the lift coefficient of the powered wing could be increased by the propeller slipstream when the rotational speed was increased and high-lift devices were deployed. Moving the nacelle/propeller closer to the wing in the vertical direction indicated higher lift augmentation than a shift in the longitudinal direction. A pitch-down nacelle inclination enhanced the lift performance of the system much better than vertical and horizontal variation of the nacelle locations and showed that the powered wing can sustain higher angles of attack near maximum lift performance. C.D.

A92-26248#
THE EFFECT OF BLADE SOLIDITY ON THE AERODYNAMIC LOSS OF A TRANSONIC TURBINE CASCADE
R. L. DOUGHTY, H. L. MOSES (Virginia Polytechnic Institute and State University, Blacksburg), and B. A. GREGORY (GE Aircraft Engines, Cincinnati, OH) AIAA, Aerospace Sciences Meeting

and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 12 p. Research sponsored by GE Aircraft Engines. refs
(AIAA PAPER 92-0393) Copyright

Past research explored the total pressure loss of a baseline transonic turbine blade, which is based on the pitching profile of a high pressure turbine rotor for a large commercial aircraft gas turbine. In the current experiment, 10-percent changes in the solidity ratio were accomplished by varying the blade pitch and slightly changing the blade stagger to maintain a constant throat-to-spacing ratio. Differences in the average exit angle and Mach number between solidity cases at constant pressure ratio were minimized with this method. Cascades with three different solidities were tested in a transonic blow-down wind tunnel. Total pressure loss and static pressure measurements were obtained, along with shadowgraphs of the shock structure. In addition, inviscid calculations were made for each case. Static pressure contours and Mach number profiles from the calculations were compared with the experimental results. A 10-percent decrease in solidity caused no cascade loss penalty as compared to the baseline solidity for a wide range of Mach numbers. Author

A92-26254#
MAXIMUM LIFT PREDICTION FOR MULTIELEMENT WINGS
WALTER O. VALAREZO and VINCENT D. CHIN (Douglas Aircraft Co., Long Beach, CA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 14 p. refs
(AIAA PAPER 92-0401) Copyright

This paper describes the development of a semi-empirical three-dimensional method for the prediction of maximum lift for complex multielement wing geometries. The method is a combination of cost-effective and reliable CFD technology (a surface panel method) and an empirically observed phenomenon occurring at maximum lift conditions that is introduced here as the Pressure Difference Rule. The panel method solutions used in conjunction with the Pressure Difference Rule yield surprisingly accurate predictions of maximum lift for both clean wings as well as multielement wings. Comparisons with experimental data are presented for increasingly complex high-lift wing geometries including full transport aircraft configured for landing. Author

A92-26255*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
LOW ASPECT RATIO WING CODE VALIDATION EXPERIMENT
MICHAEL E. OLSEN and H. L. SEEGMILLER (NASA, Ames Research Center, Moffett Field, CA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 14 p. refs
(AIAA PAPER 92-0402) Copyright

An experiment was performed on a low-aspect ratio wing to define the limits of the validity of codes which are used to predict the flow over modern fighter configurations. The focus of the experiment is to provide data at or near the true operating conditions of transonic aircraft. The Reynolds numbers reached in this experiment reproduce those experienced by an aircraft with a 5-m root chord, flying at 14 to 16 km, from Mach 0.6 to 0.8. The angle-of-attack range of the experiment extends into the regime of leading-edge separation. Author

A92-26256#
COMPUTATIONAL ANALYSIS OF HIGH-SPEED EJECTION SEATS
STEVEN C. CARUSO and MICHAEL R. MENDENHALL (Nielsen Engineering and Research, Inc., Mountain View, CA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 12 p. refs
(Contract N62269-90-C-0264)
(AIAA PAPER 92-0403) Copyright

This paper documents the results of a study demonstrating the use of analytical computational fluid dynamics methods to predict the aerodynamic characteristics and flowfield details of a typical ejection seat with an occupant. Two-dimensional Navier-Stokes codes were used to predict the steady and time-dependent transonic and supersonic flow characteristics for a series of ejection seats defined by the longitudinal plane of symmetry through the center of the seat. Structured and unstructured grids were considered in the calculations to demonstrate the capability of the method, and comparisons of measured and predicted forces and moments are presented to validate the trends produced by the computational techniques. Author

A92-26257#
AN INTERACTIVE BOUNDARY-LAYER APPROACH TO MULTIELEMENT AIRFOILS AT HIGH LIFT
TUNCER CEBECL, JULAN JAU (Douglas Aircraft Co., Long Beach, CA), and DOMINICO VITIELLO (Alenia Aeronautica, Pomigliano d'Arco, Italy) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 13 p. refs
(AIAA PAPER 92-0404) Copyright

A calculation method based on an interactive boundary-layer approach to multielement airfoils is described and is applied to three types of airfoil configurations with and without flap-wells in order to demonstrate the applicability of the method to general high-lift configurations. This method, well tested for single airfoils as a function of shape, angle of attack and Reynolds number, is here shown to apply equally well to two-element airfoils and their wakes, to a flap-well region, and to a three-element arrangement which includes the effects of co-flowing regions, a flap well, and the wake of the elements. In addition to providing accurate representation of these flows, the method is general so that its extension to three-dimensional arrangements is likely to provide a practical, accurate and efficient tool to assist the design process. Author

A92-26258*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
EFFICIENT SIMULATION OF INCOMPRESSIBLE VISCOUS FLOW OVER SINGLE AND MULTI-ELEMENT AIRFOILS
STUART E. ROGERS, N. L. WILTBERGER, and DOCHAN KWAK (NASA, Ames Research Center, Moffett Field, CA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 11 p. refs
(AIAA PAPER 92-0405) Copyright

Incompressible viscous turbulent flows over single- and multiple-element airfoils are numerically simulated in an efficient manner by solving the incompressible Navier-Stokes equations. The solution algorithm uses the method of pseudocompressibility with an upwind-differencing scheme for the convective fluxes and an implicit line-relaxation scheme to study high-lift take-off and landing configurations and to compute lift and drag at various angles of attack up to stall. Two different turbulence models are tested in computing the flow over an NACA 4412 airfoil. The approach used for multiple-element airfoils involves the use of multiple zones of structured grids fitted to each element. Two different approaches are compared: a patched system of grids and an overlaid Chimera system of grids. Computational results are presented for two-element, three-element, and four-element airfoil configurations. Excellent agreement with experimental surface-pressure coefficients is seen. The code converges in less than 200 iterations, requiring on the order of one minute of CPU time on a CRAY YMP per element in the airfoil configuration. Author

A92-26259#
EFFECTS OF TIP REYNOLDS NUMBER AND TIP ASYMMETRY ON VORTEX WAKES OF AXISYMMETRIC BODIES AT VARIOUS ANGLES OF ATTACK
DAVID H. BRIDGES and HANS G. HORNUNG (California Institute of Technology, Pasadena) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 14 p. refs
(Contract N00014-90-J-1305)
(AIAA PAPER 92-0406) Copyright

The effects of Reynolds number based on tip radius and of slight tip asymmetry on the flow past a right circular cone at various angles of attack have been studied. The boundaries of regions in the tip Reynolds number-angle of attack plane within which various separation patterns occur have been determined

for the cone with hemispherical tips. A possible mechanism for a change from a tip flow separation pattern that normally results in high vortex wake asymmetry to a separation pattern that normally results in low vortex wake asymmetry has been identified. A sinusoidal variation in vortex wake asymmetry for a cone at 45 degrees angle of attack and with a specially-designed and constructed elliptic cross-section tip has been documented, and some interesting connections between the vortex wake geometry for this body and the Foeppl potential flow solution for two stationary vortices behind a circular cylinder in cross flow have been discovered. Author

A92-26260*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

THE EFFECTS OF BLOWING ON DELTA WING VORTICES DURING DYNAMIC PITCHING AT HIGH ANGLES OF ATTACK

L. S. MILLER (Wichita State University, KS) and BRENDA E. GILE (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 9 p. refs

(AIAA PAPER 92-0407) Copyright

An experimental investigation was conducted in a water tunnel to identify the effects of apex blowing on two delta-wing models undergoing constant pitch-rate motion. One wing was of 60-degree sweep and the other was of 76-degree sweep. Flow visualization methods were utilized to determine vortex burst locations for a wide range of pitch-up (nose up) and plunge (nose down) rates, apex jet strengths, and blowing directions. Results indicate that blowing along the 60-degree wing vortex core or along the 76-degree wing centerline results in a notable improvement in vortex behavior under both static and dynamic conditions. The results are most dramatic during dynamic plunging (nose down) conditions, where blowing resulted in the reformation of vortices with significant length. Author

A92-26261*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

EFFECT OF UPSTREAM DISTURBANCE ON FLOW ASYMMETRY

DAVID DEGANI (Technion - Israel Institute of Technology, Haifa) and MURRAY TOBAK (NASA, Ames Research Center, Moffett Field, CA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 12 p. refs

(Contract NCC2-632)

(AIAA PAPER 92-0408) Copyright

Results are presented of an experimental study aimed at revealing the origin of the asymmetric mean flow that occurs on pointed bodies of revolution at moderate-to-high angles of attack. The placement of a small fixed disturbance (a minute spherical bead) on a very thin wire at various locations in the flow near the tip of the model is shown to provoke the same range of behavior of the asymmetric flow that was produced earlier by use of a controlled retractable wire protuberance, here without touching or altering the tip at all. Results remain consistent with the presence of a convective instability mechanism, and demonstrate the potential for a precise mapping of the body's receptivity to fixed disturbances in the flowfield. Author

A92-26262#

NUMERICAL AND EXPERIMENTAL ANALYSIS OF VORTEX SHEETS BEHIND LIFTING SURFACES

M. P. WARZECHA (Boeing Commercial Airplane Group, Seattle, WA) and H. H. HORNG (Michigan, University, Ann Arbor) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 9 p. refs

(AIAA PAPER 92-0409) Copyright

Vortex wake phenomena are crucial to modern aircraft design and operation. Based on an established theory, this study presents a computational model of the vortex sheet evolution behind lifting surfaces. Furthermore, experiments are conducted to assess the numerical results of this study. The computational model is applied to understand how alterations in planform geometry affect engine exhaust dispersion rate. Many other potential applications exist for this type of model. Author

A92-26263*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

COMPUTATIONAL STUDY OF THE AERODYNAMICS AND CONTROL BY BLOWING OF ASYMMETRIC VORTICAL FLOWS OVER DELTA WINGS

KEN CRAIG (Stanford University, CA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 28 p. Research supported by NASA. refs

(AIAA PAPER 92-0410) Copyright

The complicated flowfield around a rounded leading-edge delta wing was calculated at angles of attack and yaw with and without tangential leading-edge blowing, using thin-layer Navier-Stokes equations. The effectiveness of blowing for providing roll control at high angle of attack was illustrated, and the saturation effect of increased blowing was captured well. The effect of sideslip was shown to be analogous to asymmetric blowing. O.G.

A92-26264*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

NUMERICAL INVESTIGATION OF PERFORMANCE DEGRADATION OF WINGS AND ROTORS DUE TO ICING

OH J. KWON and LAKSHMI N. SANKAR (Georgia Institute of Technology, Atlanta) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 14 p. refs

(Contract NAG3-768)

(AIAA PAPER 92-0412) Copyright

The aerodynamic load characteristics and the performance degradation of moderate aspect ratio wings and rotors with simulated glaze leading-edge ice have been studied using a three-dimensional, compressible Navier-Stokes solver. The effect of a splitter plate at the wing root on both clean and iced wing configurations has been studied and the results are compared with the experiment. A significant difference has been observed with and without splitter plates in the magnitude of flow separation and aerodynamic loading at the inboard stations for the iced wing at 8-deg angle of attack. Inviscid calculations were performed and compared with viscous calculations to investigate whether the performance of iced swept wings can be inexpensively predicted using Euler methods. It is shown that inviscid calculations predict higher aerodynamic loading than viscous calculations, and cannot model separation effects. A typical nonlifting helicopter rotor in forward flight condition is also studied, and the penalty due to the leading-edge ice formation on the required torque is numerically demonstrated. Author

A92-26265*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

FINITE WING AERODYNAMICS WITH SIMULATED GLAZE ICE

A. KHODADOUST, M. B. BRAGG, M. KERHO, S. WELLS, and M. R. SOLTANI (Illinois, University, Urbana) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 18 p. Research supported by NASA. refs

(AIAA PAPER 92-0414) Copyright

The effect of a simulated glaze ice accretion on the aerodynamic performance of a three-dimensional wing is studied experimentally. The model used for these tests was a semi-span wing of effective aspect ratio five, mounted from the sidewall of the UIUC subsonic wind tunnel. The model has an NACA 0012 airfoil section on a rectangular, untwisted planform with interchangeable leading edges to allow for testing both the baseline and the iced wing geometry. A three-component sidewall balance was used to measure lift, drag and pitching moment on the clean and iced model. A four-beam two-color fiberoptic laser Doppler velocimeter (LDV) was used to map the flowfield along several spanwise cuts on the model. Preliminary results from LDV scans, which will be the bulk of this paper, are presented following the force balance measurement results. Initial comparison of LDV surveys compare favorably with inviscid theory results and 2D split hot-film measurements near the model surface. Author

A92-26266*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
AUTOMATIC GRID GENERATION FOR ICED AIRFOIL FLOWFIELD PREDICTIONS
STEVEN C. CARUSO and MOHAMMAD FARSHCHI (Nielsen Engineering and Research, Inc., Mountain View, CA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 13 p. refs
(Contract NAS3-26059)
(AIAA PAPER 92-0415) Copyright

This paper describes a flowfield mesh generation procedure which has been developed specifically for dealing with geometrically complex and time-dependent leading edge ice accretions on airfoils. The method produces an unstructured mesh using an automatic node point generation scheme that requires minimal user input. Flowfield predictions are obtained by solving the Navier-Stokes equations on an unstructured, triangular mesh. Laminar and turbulent flowfield calculations are presented which demonstrate the new method's ability to produce suitable meshes for such computations. Author

A92-26267*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A TURBULENCE MODEL FOR ICED AIRFOILS AND ITS VALIDATION
JAIWON SHIN (NASA, Lewis Research Center, Cleveland, OH), HSUN H. CHEN, and TUNCER CEBECI (California State University, Long Beach) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 16 p. Previously announced in STAR as N92-15052. refs
(AIAA PAPER 92-0417) Copyright

A turbulence model based on the extension of the algebraic eddy viscosity formulation of Cebeci and Smith developed for two-dimensional flows over smooth and rough surfaces is described for iced airfoils and validated for computed ice shapes obtained for a range of total temperatures varying from 28 to -15 F. The validation is made with an interactive boundary layer method which uses a panel method to compute the inviscid flow and an inverse finite difference boundary layer method to compute the viscous flow. The interaction between inviscid and viscous flows is established by the use of the Hilbert integral. The calculated drag coefficients compare well with recent experimental data taken at the NASA-Lewis Icing Research Tunnel (IRT) and show that, in general, the drag increase due to ice accretion can be predicted well and efficiently. Author

A92-26268#
DEVELOPMENT OF AN ANALYTICAL METHOD TO PREDICT HELICOPTER MAIN ROTOR PERFORMANCE IN ICING CONDITIONS
RANDALL K. BRITTON (Sverdrup Technology, Inc., Brook Park, OH) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 25 p. refs
(AIAA PAPER 92-0418) Copyright

Currently, an effort is being made by the NASA Lewis Research Center to develop an analytical procedure for calculating the performance degradation a helicopter experiences while operating in an icing encounter. A short discussion is given of the possibilities for performing such a calculation and reasons given for choosing the present approach. A complete description of the jobstream is given. Data taken from the NASA Lewis model rotor icing test program is used as a data base for comparison. Comparisons are also made between this method and the more traditional method based on empirical correlation. Conclusions are drawn as to how well results compare with experiment. Guidelines for calculation procedures are given. Limitations of this type of jobstream are pointed out and recommendations are made for future improvements. Author

A92-26274#
PREDICTIONS OF COMPRESSIBLE VISCOUS FLOWS AT ALL MACH NUMBER USING PRESSURE CORRECTION, COLLOCATED PRIMITIVE VARIABLES AND NON-ORTHOGONAL MESHES
M. H. KOBAYASHI and J. C. F. PEREIRA (Instituto Superior Tecnico, Lisbon, Portugal) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 8 p. Research supported by CEC. refs
(AIAA PAPER 92-0426) Copyright

This paper is concerned with the development and application of an algorithm to highly interactive compressible flows at all Mach number regimes. The algorithm is based on the finite-volume method using nonstaggered, nonorthogonal grids. The accuracy of different convection discretization schemes is investigated. The employed schemes are: second-order upwind, central differencing and the quadratic upwind scheme, as well as a second-order upwind flux limiter constructed from the TVD-theory. Flow problems with shock and shock/boundary-layer interactions are solved aiming to assess the relative accuracy of the schemes. It is shown that the SIMPLES algorithm together with the second-order upwind flux limiter scheme is a robust and accurate method for solving full Navier-Stokes equations for a wide range of Mach and Reynolds numbers. Author

A92-26275#
SOME THOUGHTS ON CONICAL FLOW ASYMMETRY
L. E. ERICSSON (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 14 p. refs
(Contract F33615-87-C-3607)
(AIAA PAPER 92-0427) Copyright

Experimental results obtained on slender bodies of revolution at high angles of attack have been analyzed. It is concluded that conical vortex asymmetry is generated by asymmetric crossflow separation and is a viscous flow phenomenon. Inviscid vortex flow modeling based on experimentally determined separation lines can be performed only for laminar flow conditions. In full-scale flight boundary layer transition plays an important role in the development of asymmetric crossflow separation, preventing the successful use of inviscid modeling techniques. O.G.

A92-26276#
CROSS-FLOW SEPARATION ON A PROLATE SPHEROID AT ANGLES OF ATTACK
SEUNGKI AHN and ROGER L. SIMPSON (Virginia Polytechnic Institute and State University, Blacksburg) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 10 p. refs
(Contract N00014-87-K-0816)
(AIAA PAPER 92-0428) Copyright

For the identification of the general flow pattern and better understanding of the flow field around a 6 to 1 prolate spheroid, surface-oil-flow visualization tests were performed. The angle of attack effect and Reynolds number effect on the separation location are studied with natural transition. It was found that there exists a critical Reynolds number at which the flow characteristics of the afterbody changes. Above this Reynolds number, as the Reynolds number increases, the separation lines do not change its circumferential location but stretch to the upstream of the body. For the low super critical Reynolds number range, the angle of attack effect on the location of the primary separation is not as prominent as in the higher Reynolds number range where cross-flow component effect becomes dominant. Author

A92-26277#
EXPERIMENTAL INVESTIGATION OF A THREE-DIMENSIONAL BLUFF-BODY WAKE
A. AHMED, M. J. KHAN, and B. BAYS-MUCHMORE (Texas A & M University, College Station) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 13 p. refs
(AIAA PAPER 92-0429) Copyright

The effects of the 3D separation line topology on the

development of the turbulent wake of a 3D bluff body are explored. Flow visualizations, total pressure surveys, and laser Doppler velocimetry measurements of the mean velocity field and Reynolds stresses are presented and analyzed. The primary significance of three-dimensionality of the wavy-cylinder separation lines is that streamwise vortices form near the nodal points of separation. The turbulence structures in the separated boundary-layer behind the saddle points of separation develop in a manner similar to those in a simple mixing layer. Behind the nodal points of separation, the 'rolling up' of the separated boundary layer delays or suppresses the development of the shear-layer turbulence. The formation of the trailing vortices results in a wavy-cylinder wake that is narrowest behind the geometric nodes and widest behind the geometric saddles. C.D.

A92-26280#
INFLUENCE OF WING SHAPES ON THE SURFACE PRESSURE FLUCTUATIONS OF A WING-BODY JUNCTION
SEMIH M. OLCMEN and ROGER L. SIMPSON (Virginia Polytechnic *Institute and State University, Blacksburg)* AIAA, *Aerospace* Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 12 p. refs
(Contract N00014-88-C-0291; N00014-90-J-1909)
(AIAA PAPER 92-0433) Copyright

The body surface pressure fluctuations along the stagnation streamlines of several wing-body junctions were measured with microphones. The wing shapes are of a 3:2 semi-elliptical-nosed NACA 0020-tailed body, a parallel centerbody model, a tear drop shape, Sand 1850, NACA 0015 and NACA 0012. The oil-flow visualizations revealed the limiting streamline structure on the wall where the models were mounted. Measurements were conducted at a nominal reference velocity of 32.5 m/sec and Reynolds number based on approach momentum thickness of 4450. Pressure fluctuation measurements at the nose region show the existence of the bimodal structure and oil flow visualization pictures show the primary separation regions, line of low shear, and the fish tail shaped wake region. The measurements show that the pressure fluctuations and the primary separation line location at the nose highly differ depending on the nose geometry. The histograms of the pressure fluctuation data show that the fluctuations are different than Gaussian. A relation between the pressure fluctuations and the body geometry is also expressed. Author

A92-26281#
AN EXPERIMENTAL STUDY OF A TURBULENT WING-BODY JUNCTION AND WAKE FLOW
J. L. FLEMING, R. L. SIMPSON, and W. J. DEVENPORT (Virginia Polytechnic Institute and State University, Blacksburg) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 13 p. refs
(Contract N00014-89-J-1275; N00014-90-J-1909)
(AIAA PAPER 92-0434) Copyright

Measurements were conducted in incompressible turbulent flow around the wing-body junction formed by a 3:2 semielliptic nose/NACA 0020 tail section and a flat plate. The position of maximum V velocities, corresponding directly to the line of low shear location, is intimately related to the major flow features associated with the horseshoe junction vortex. The primary horseshoe vortex flow structure is elliptically shaped and near the wall. The spanwise velocity gradients contribute the majority of the streamwise vorticity and characterize its distribution. Conflicting directions of the skewing-induced and vortex-induced flows near the wall control the flow separation. The far wake flow distortion patterns reveal a more diffuse vortical flow structure. Increases in Re(0) increase the local mean flow distortions and gradients near the wall in the nose region. A factor termed the momemtum deficit factor may directly affect the mean junction flow characteristics. C.D.

A92-26283*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
TURBULENCE MODELING FOR HIGH SPEED FLOWS
T. J. COAKLEY (NASA, *Ames Research Center,* Moffett Field, CA) and P. G. HUANG (Eloret Institute, Sunnyvale, CA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 16 p. refs
(AIAA PAPER 92-0436) Copyright

An investigation of turbulence models for high speed flows is presented. The flows consist of simple 2D flows over flat plates and complex shock-wave boundary-layer interaction flows over ramps and wedges. The flows are typical of those encountered by high speed vehicles such as the NASP. The turbulence models investigated include various two-equation models which, as a class, are considered to be well suited to the design of high speed vehicles. A description and discussion of the specific models is given and includes both baseline or uncorrected models, and model corrections which are needed to improve predictions of complex flows. It is found that most of the models studied are able to give good predictions of the flat plate flows, and some of the models are able to predict some of the complex flows, but none of them are able to accurately predict all of the complex flows. Recommendations for future model improvements are discussed. Author

A92-26284# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
A COMPARATIVE STUDY OF TURBULENCE MODELS FOR OVERSET GRIDS
KEVIN J. RENZE (Iowa State University of Science and Technology, Ames), PIETER G. BUNING (NASA, Ames Research Center, Moffett Field, CA), and R. G. RAJAGOPALAN (Iowa State University of Science and Technology, Ames) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 16 p. refs
(Contract NCA2-486; NGT-40018)
(AIAA PAPER 92-0437) Copyright

The implementation of two different types of turbulence models for a flow solver using the Chimera overset grid method is examined. Various turbulence model characteristics, such as length scale determination and transition modeling, are found to have a significant impact on the computed pressure distribution for a multielement airfoil case. No inherent problem is found with using either algebraic or one-equation turbulence models with an overset grid scheme, but simulation of turbulence for multiple-body or complex geometry flows is very difficult regardless of the gridding method. For complex geometry flowfields, modification of the Baldwin-Lomax turbulence model is necessary to select the appropriate length scale in wall-bounded regions. The overset grid approach presents no obstacle to use of a one- or two-equation turbulence model. Both Baldwin-Lomax and Baldwin-Barth models have problems providing accurate eddy viscosity levels for complex multiple-body flowfields such as those involving the Space Shuttle. C.D.

A92-26285#
A ONE-EQUATION TURBULENCE MODEL FOR AERODYNAMIC FLOWS
P. R. SPALART and S. R. ALLMARAS (Boeing Commercial Airplane Group, Seattle, WA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 23 p. refs
(AIAA PAPER 92-0439) Copyright

A transport equation for turbulent viscosity is developed and a turbulence model results which is local and therefore compatible with grids of any structure and Navier-Stokes solvers in 2D or 3D. The model is numerically forgiving in terms of near-wall resolution and stiffness and yields fairly rapid convergence to steady state. The wall and free-stream boundary conditions are trivial. The model yields relatively smooth laminar-turbulent transition at points specified by the user. It is powerful enough to be calibrated on 2D mixing layers, wakes, and flat-plate boundary layers and yields satisfactory predictions of boundary layers in pressure gradients. Shock-induced separation at a blunt trailing edge are treated as examples. The model appears to be a good candidate for flows including high-lift systems or wing-body junctions. C.D.

A92-26288*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
QUALITY ASSESSMENT OF TWO- AND THREE-DIMENSIONAL UNSTRUCTURED MESHES AND VALIDATION OF AN UPWIND EULER FLOW SOLVER
PAUL R. WOODARD (Purdue University, West Lafayette, IN), JOHN T. BATINA (NASA, Langley Research Center, Hampton, VA), and HENRY T. Y. YANG (Purdue University, West Lafayette, IN) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 14 p. refs
(Contract NAG1-372)
(AIAA PAPER 92-0444) Copyright
Quality assessment procedures are described for two-dimensional unstructured meshes. The procedures include measurement of minimum angles, element aspect ratios, stretching, and element skewness. Meshes about the ONERA M6 wing and the Boeing 747 transport configuration are generated using an advancing front method grid generation package of programs. Solutions of Euler's equations for these meshes are obtained at low angle-of-attack, transonic conditions. Results for these cases, obtained as part of a validation study demonstrate accuracy of an implicit upwind Euler solution algorithm. Author

A92-26291*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A FAST IMPLICIT UPWIND SOLUTION ALGORITHM FOR THREE-DIMENSIONAL UNSTRUCTURED DYNAMIC MESHES
JOHN T. BATINA (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 7 p. Previously announced in STAR as N92-15050. refs
(AIAA PAPER 92-0447) Copyright
A fast implicit upwind algorithm for the solution of the time-dependent Euler equations is presented for aerodynamic analysis involving unstructured dynamic meshes. The spatial discretization of the scheme is based on the upwind approach of Roe, referred to as flux-difference splitting (FDS). The FDS approach is naturally dissipative and captures shock waves and contact discontinuities sharply. The temporal discretization of the scheme involves an implicit time-integration using a two-sweep Gauss-Seidel relaxation procedure. The procedure is computationally efficient for either steady or unsteady flow problems. A detailed description is given of the implicit upwind solution algorithm along with results which assess the capability. The results are presented for the NACA 0012 airfoil and for the Boeing 747 aircraft. The 747 geometry includes the fuselage, wing, horizontal and vertical tails, under-wing pylons, and flow-through engine nacelles. Euler solutions for the 747 aircraft on an unstructured tetrahedral mesh containing approximately 100,000 cells were obtained to engineering accuracy in less than one hour CPU time on a Cray-2 computer. Author

A92-26317#
SEPARATION-INDUCED SELF-EXCITED STRUCTURAL OSCILLATIONS
L. E. ERICSSON (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 13 p. refs
(AIAA PAPER 92-0486) Copyright
Because of steadily increasing performance demands both aircraft and missiles operate at high angles of attack where separated flow often has a dominant influence on especially the unsteady aerodynamics. The penetration of the buffet boundary usually changes the structural response from the buffet-type to the self-excited type. This transfer occurs when the structural response starts interacting with the unsteady flow separation, generating negative aerodynamic damping. Separated flow aerodynamics are usually very nonlinear, and the self-excited response frequently takes the form of a limit-cycle oscillation. Author

A92-26318#
A MULTIBODY APPROACH TO MODELING TILT-WING ROTORCRAFT DYNAMICS
PATRICK J. O'HERON (Dynacs Engineering Co., Inc., Palm Harbor, FL), DONALD L. KUNZ (McDonnell Douglas Helicopter Co., Mesa, AZ), PARVIZ E. NIKRAVESH, and ARA ARABYAN (Arizona, University, Tucson) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 9 p. Research supported by McDonnell Douglas Helicopter Co. refs
(AIAA PAPER 92-0487) Copyright
A model is presented which can be used to compute the dynamics associated with the conversion of advanced rotorcraft between the helicopter and fixed-wing modes. The model accounts for unsteadiness and nonlinearity in the near-wake aerodynamics and can be used to compute the far-wake aerodynamics and the blade pitch settings needed to achieve a desired flight path. The simulation flight path is used to show that the model can effectively perform vertical takeoff, hover, tilt-wing conversion, and high-speed forward flight maneuvers. C.D.

A92-26322*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SHOCK INTERFERENCE PREDICTION USING DIRECT SIMULATION MONTE CARLO
ANN B. CARLSON and RICHARD G. WILMOTH (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 9 p. refs
(AIAA PAPER 92-0492) Copyright
The shock interaction produced when an incident shock impinges on an inlet cowl lip is investigated for a cowl lip radius of 0.1 in. and flight conditions of Mach 15 and 35-km altitude. This problem is of interest in the design of hypersonic flight vehicles because the interference heating at the cowl lip surface from such a shock interaction is expected to be very high and the design of adequate thermal protection in this region will be challenging. Noncontinuum effects may be significant at this combination of altitude and small dimensions. If this is so, a computational solution based on the Navier-Stokes equations could significantly overpredict the surface heating on the cowl lip. Therefore, a kinetic theory solution technique, direct simulation Monte Carlo (DSMC), is used to predict the flowfield and surface heating. The details of modeling this problem and some preliminary results are presented. The same qualitative flow patterns are seen with DSMC and a continuum solution of the shock interference case, but the peak heating predicted with DSMC is somewhat lower. Author

A92-26323# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
MONTE CARLO SIMULATION OF REENTRY FLOWS WITH IONIZATION
JEFF C. TAYLOR (North Carolina State University, Raleigh), ANN B. CARLSON (NASA, Langley Research Center, Hampton, VA), and H. A. HASSAN (North Carolina State University, Raleigh) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 10 p. Research supported by USAF and U.S. Navy. refs
(Contract NCC1-112; NAGW-1022; NAGW-1331)
(AIAA PAPER 92-0493) Copyright
The Direct Simulation Monte Carlo method is applied to a rarefied, weakly ionized, hypersonic flow over a blunt axisymmetric body. An ionization model based on the concept of ambipolar diffusion is used and a model for the sheath is presented. The effects of the new modeling techniques are investigated for flow over the Project Fire II configuration at 11.37 km/s at an altitude of 84.6 km. The calculated results are presented and compared with both experimental data and solutions where ionization effects were not included. In general, the calculated results overpredict the experimental values by about 15-20 percent. Author

A92-26324# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
MONTE CARLO SIMULATION OF ENTRY IN THE MARTIAN ATMOSPHERE
DAVID B. HASH and H. A. HASSAN (North Carolina State University, Raleigh) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 7 p. Research supported by USAF and U.S. Navy. refs
(Contract NCC1-112; NAGW-1022; NAGW-1331)
(AIAA PAPER 92-0494) Copyright

The Direct Simulation Monte Carlo method of Bird is used to investigate the characteristics of low density hypersonic flowfields for typical aerobrakes during Martian atmospheric entry. The method allows for both thermal and chemical nonequilibrium. Results are presented for a sixty-degree spherically blunt cone for various nose radii and altitudes. Author

A92-26325*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
HYPERSONIC RAREFIED FLOW PAST SPHERES INCLUDING WAKE STRUCTURE
VIRENDRA K. DOGRA (Vigyan Research Associates, Inc., Hampton, VA), JAMES N. MOSS, RICHARD G. WILMOTH, and JOSEPH M. PRICE (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 12 p. refs
(AIAA PAPER 92-0495)

Results of a numerical study using the direct simulation Monte Carlo method are presented for hypersonic rarefied flow past spheres. The flow conditions considered are those corresponding to low density wind tunnel test conditions. The set of the experimental conditions for the calculations encompasses the transitional to near-continuum flow regimes. Comparison of the calculated drag with experimental results shows good agreement to well within the experimental error. Particular attention is focused on the wake structure. Calculations show that the wake is very rarefied with considerable thermal nonequilibrium for all the cases considered. No flow separation is observed in the wake for the near-continuum case where a vortex has been predicted by Navier-Stokes type calculations. Author

A92-26326*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AN APPROXIMATE VISCOUS SHOCK LAYER TECHNIQUE FOR CALCULATING NONEQUILIBRIUM HYPERSONIC FLOWS ABOUT BLUNT-NOSED BODIES
F. M. CHEATWOOD and F. R. DEJARNETTE (North Carolina State University, Raleigh) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 12 p. refs
(Contract NCC1-100)
(AIAA PAPER 92-0498) Copyright

An approximate axisymmetric method has been developed which can reliably calculate nonequilibrium fully viscous hypersonic flows over blunt-nosed bodies. By substituting Maslen's second-order pressure expression for the normal momentum equation, a simplified form of the viscous shock layer (VSL) equations is obtained. This approach can solve both the subsonic and supersonic regions of the shock layer without a starting solution for the shock shape. This procedure is significantly faster than the parabolized Navier-Stokes and VSL solvers and would be useful in a preliminary design environment. Solutions have been generated for air flows over several analytic body shapes. Surface heat transfer and pressure predictions are comparable to VSL results. Computed heating rates are in good agreement with experimental data. The present technique generates its own shock shape as part of its solution, and therefore could be used to provide more accurate initial shock shapes for higher-order procedures which require starting solutions. Author

A92-26327*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AN ENGINEERING AERODYNAMIC HEATING METHOD FOR HYPERSONIC FLOW
CHRISTOPHER J. RILEY (NASA, Langley Research Center, Hampton, VA) and FRED R. DEJARNETTE (North Carolina State University, Raleigh) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 11 p. refs
(Contract NCC1-100)
(AIAA PAPER 92-0499) Copyright

A capability to calculate surface heating rates has been incorporated in an approximate three-dimensional inviscid technique. Surface streamlines are calculated from the inviscid solution, and the axisymmetric analog is then used along with a set of approximate convective-heating equations to compute the surface heat transfer. The method is applied to blunted axisymmetric and three-dimensional ellipsoidal cones at angle of attack for the laminar flow of a perfect gas. The method is also applicable to turbulent and equilibrium-air conditions. The present technique predicts surface heating rates that compare favorably with experimental (ground-test and flight) data and numerical solutions of the Navier-Stokes (NS) and viscous shock-layer (VSL) equations. The new technique represents a significant improvement over current engineering aerothermal methods with only a modest increase in computational effort. Author

A92-26356
EXPERIMENTAL AND THEORETICAL STUDIES ON HELICOPTER ROTOR FUSELAGE INTERACTION
N. BETTSCHART, R. HANOTEL, D. ILBAS, and A. DESOPPER (ONERA, Chatillon, France) (European Rotorcraft Forum, 17th, Berlin, Federal Republic of Germany, Sept. 24-27, 1991) ONERA, TP no. 1991-197, 1991, 14 p. refs
(ONERA, TP NO. 1991-197)

The rotor/fuselage interactional aerodynamics of helicopters are investigated experimentally and analytically. The unsteady velocity field around a scaled helicopter model in forward flight are measured with a three-component laser-Doppler velocimeter. Rotor fuselage calculations are analyzed with an iterative coupling method based on a panel method for the fuselage and a lifting-line code for the rotor. An azimuth marching technique is employed to couple the codes, and it is shown that the laser-Doppler velocimetry techniques can describe the complex configuration including the moving surfaces. The results demonstrate that fuselage effects should be considered to accurately describe the flow characteristics on the inboard part of the rotor disk and to understand the rotor-wake geometry. The experimental results confirm the predictions and conclusions based on the analytical methodology. C.C.S.

A92-26357
THEORETICAL AND EXPERIMENTAL STUDIES OF HELICOPTER ROTOR/FUSELAGE INTERACTION [ETUDES THEORIQUES ET EXPERIMENTALES DE L'INTERACTION ROTOR/FUSELAGE D'HELICOPTERES]
N. BETTSCHART, R. HANOTEL, D. ILBAS, and A. DESOPPER (ONERA, Chatillon, France) ONERA, TP no. 1991-198, 1991, 20 p. In French. refs
(ONERA, TP NO. 1991-198)

A test was conducted in the ONERA S2 Chalais wind tunnel to measure the unsteady velocity field around a helicopter model in forward flight. Theoretically, an iterative coupling method is developed for rotor fuselage calculations, based on a panel method (source and doublet singularities) for the fuselage and a lifting line code for the rotor. Comparisons show that the fuselage effects must be taken into account, especially for the rotor wake geometry and for the flow conditions on the inboard section of the blade. R.E.P.

A92-26364
WALL PRESSURE WAVENUMBER-FREQUENCY SPECTRUM BENEATH A TURBULENT BOUNDARY LAYER MEASURED WITH TRANSDUCER ARRAYS CALIBRATED WITH AN ACOUSTICAL METHOD
ERIC MANOHA (ONERA, Chatillon, France) ONERA, TP no. 1991-212, 1991, 16 p. Research sponsored by Service Technique

des Constructions et Armes Navales. refs
(ONERA, TP NO. 1991-212)

Wavenumber frequency spectra of the wall pressure field beneath a turbulent boundary layer have been measured by linear arrays of flush-mounted transducers subjected to the specific technique of two-dimensional space-time Fourier transform. Measurements were made in an anechoic wind facility on a 4 m long, 0.32 m-diameter cylindrical body with free-stream velocities between 10 and 80 m/s. Two streamwise arrays of 32 transducers having different spacing were used. An innovative acoustical method allowed a simultaneous, phase level, and broadband calibration of all the elements of an array. At low frequencies, unaliased wavenumber spectra were obtained, that fit the classical models when plotted in a normalized presentation. At high frequencies, the pressure sensors were not large enough to correctly attenuate the convective region, and the measured low wavenumber levels were probably highly overestimated. Author

A92-26370
AERODYNAMIC COMPUTATIONS OF HIGH-SPEED TRANSONIC PROPELLERS [CALCULS AERODYNAMIQUES DES HELICES RAPIDES TRANSSONIQUES]
P. GARDAREIN (ONERA, Chatillon, France) ONERA, TP no. 1991-218, 1991, 30 p. In French. Research supported by Service Technique des Programmes Aeronautiques. refs
(ONERA, TP NO. 1991-218)

A study of recent research conducted on high-speed counterrotating propfans is presented. For design and parametric analyses a simple curved lifting line method has been used with a more sophisticated technique based on 3D Euler equations (CAPRI code) employed for a fine analysis of the flow field, with emphasis on the blade surface. An outline of the application field of these methods is given by comparing the computed results with experimental data from rotating and counterrotating propellers. R.E.P.

A92-26381
VALIDATION OF A 3D NAVIER-STOKES CODE ON EXPERIMENTAL COMPRESSOR BLADINGS [VALIDATION D'UN CODE NAVIER-STOKES 3D SUR UNE SOUFFLANTE EXPERIMENTALE]
V. COUAILLIER (ONERA, Chatillon, France), PH. VEYSSEYRE (SNECMA, Centre de Villaroche, Moissy-Cramayel, France), and A. M. VUILLOT (ONERA, Chatillon, France) (European Propulsion Forum 91, Paris, France, Nov. 13-15, 1991) ONERA, TP no. 1991-229, 1991, 19 p. In French. Research supported by DRET. refs
(ONERA, TP NO. 1991-229)

The paper presents a numerical simulation of flow in compressor bladings, and a comparison of the results obtained with those from a series of SNECMA tests. The numerical simulation was performed using a calculation code for solving the averaged Navier-Stokes equations associated with a turbulence model. This code, developed at ONERA, is included in the design chain of compressor blades at SNECMA. The numerical method is characterized by decomposition into subdomains and by a Lax-Wendroff scheme with a finite volume approach discretized on a structured mesh by subdomain. L.M.

A92-26401
UNSTEADY CIRCULATION CONTROL AERODYNAMICS OF A CIRCULAR CYLINDER WITH PERIODIC JET BLOWING
TERENCE A. GHEE and J. G. LEISHMAN (Maryland, University, College Park) AIAA Journal (ISSN 0001-1452), vol. 30, Feb. 1992, p. 289-299. Research supported by Minta-Martin Fund for Aeronautical Research. Previously cited in issue 06, p. 799, Accession no. A91-19298. refs
Copyright

A92-26402* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ENTHALPY DAMPING FOR HIGH MACH NUMBER EULER SOLUTIONS
ANUTOSH MOITRA (NASA, Langley Research Center, Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 30, Feb. 1992, p. 300, 301. Previously cited in issue 16, p. 2483, Accession no. A90-38720. refs
Copyright

A92-26403* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
NEW NONEQUILIBRIUM TURBULENCE MODEL FOR CALCULATING FLOWS OVER AIRFOILS
S. AHMED and J. C. TANNEHILL (Iowa State University of Science and Technology, Ames) AIAA Journal (ISSN 0001-1452), vol. 30, Feb. 1992, p. 302, 303. Abridged. Previously cited in issue 16, p. 2480, Accession no. A90-38626. refs
(Contract NAG1-645)
Copyright

A92-26410
FLOW PAST A SPHERE - TOPOLOGICAL TRANSITIONS OF THE VORTICITY FIELD
SUSUMU SHIRAYAMA (Institute of Computational Fluid Dynamics, Tokyo, Japan) AIAA Journal (ISSN 0001-1452), vol. 30, Feb. 1992, p. 349-358. Previously cited in issue 21, p. 3290, Accession no. A90-45916. refs
Copyright

A92-26411
EXPERIMENTAL INVESTIGATION OF NORMAL-SHOCK/TURBULENT-BOUNDARY-LAYER INTERACTIONS WITH AND WITHOUT MASS REMOVAL
M. J. MORRIS, M. SAJBEN, and J. C. KROUTIL (McDonnell Douglas Research Laboratories, Saint Louis, MO) AIAA Journal (ISSN 0001-1452), vol. 30, Feb. 1992, p. 359-366. Previously cited in issue 06, p. 757, Accession no. A90-19823. refs
Copyright

A92-26416
UNSTEADY PRESSURE FIELD AND VORTICITY PRODUCTION OVER A PITCHING AIRFOIL
MUKUND ACHARYA and METWALLY H. METWALLY (Illinois Institute of Technology, Chicago) AIAA Journal (ISSN 0001-1452), vol. 30, Feb. 1992, p. 403-411. refs
(Contract AF-AFOSR-90-0173)
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The unsteady pressure field and the accompanying variations in the flux of spanwise vorticity from the surface were measured over a range of dimensionless pitch rates for a two-dimensional NACA 0012 airfoil model undergoing a single pitch-up motion. The results were examined to identify the mechanisms that play key roles in the initiation, development, growth, and movement of the dynamic-stall vortex. The unsteady pressure distribution over the airfoil was dominated by three features, whose emergence and evolution were used to distinguish between two classes of behavior, corresponding to low and high pitch rates. Further, it was found that the flux of vorticity from the surface originated primarily from five concentrated regions or sources, the majority of which were located over the forward portion of the airfoil surface. The behavior of vorticity flux from these sources was related to the interacting mechanisms responsible for the development of the flowfield. The change of these features in the pressure and surface vorticity flux variations with the pitch rate is described. Author

A92-26435* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
ZONAL FLOW ANALYSIS METHOD FOR TWO-DIMENSIONAL AIRFOILS
J. M. SUMMA, DANIEL J. STRASH, and SUNGYUL YOO (Analytical Methods, Inc., Redmond, WA) AIAA Journal (ISSN 0001-1452), vol. 30, Feb. 1992, p. 548, 549. Previously cited in issue 08, p. 1103, Accession no. A90-22230. refs
(Contract NAS2-12962)
Copyright

A92-26442
BASE PRESSURE IN SUPERSONIC FLOW - FURTHER THOUGHTS ABOUT A THEORY
MAURI TANNER (DLR, Goettingen, Federal Republic of Germany) AIAA Journal (ISSN 0001-1452), vol. 30, Feb. 1992, p. 565, 566. refs
Copyright
Tanner's (1987) theory for base-pressure prediction in two-dimensional supersonic flow was criticized by Magi and Gai (1988) along lines which Tanner continues to believe partly incorrect. The Magi and Gai critique is presently commented on in light of further theoretical and experimental results for base pressure in supersonic flow. O.C.

A92-26443
NUMERICAL INVESTIGATION OF UNSTEADY TRANSONIC NOZZLE FLOWS
SHEN-MIN LIANG, CHOU-JIU TSAI (National Cheng Kung University, Tainan, Republic of China), and CHIEN-KO HO (Chung Shan Institute of Science and Technology, Longtan, Republic of China) AIAA Journal (ISSN 0001-1452), vol. 30, Feb. 1992, p. 566-568. refs
(Contract NSCRC-79-0401-E006-38)
Copyright
The unsteady transonic nozzle flows presently considered is due to fluctuating backpressure. The parameters of wall thickness, fluctuating pressure amplitude, and fluctuating pressure frequency, are investigated in order to ascertain their comparative effect on shock movement, using a high-resolution TVD scheme. An illustrative numerical example is presented, giving attention to relations between the changes in both the amplitude and frequency of shock oscillation and fluctuating pressure. O.C.

A92-26797
THEORETICAL STUDY ON THE UNSTEADY AERODYNAMIC CHARACTERISTICS OF AN OSCILLATING CASCADE WITH TIP CLEARANCE (IN THE CASE OF LOADED CASCADE)
TOSHINORI WATANABE (Tokyo University of Agriculture and Technology, Koganei, Japan) and SHOJIRO KAJI (Tokyo, University, Japan) JSME International Journal, Series II (ISSN 0914-8817), vol. 35, Feb. 1992, p. 38-45. refs
Copyright
In this paper, the analytical method developed previously for oscillating cascades was refined to deal with cascades with steady aerodynamic loading. The unsteady aerodynamic force acting on the linear oscillating cascades with tip clearance was calculated numerically by means of a vortex lattice method. Tip vortices were assumed to consist of linear vortex segments, and their paths were determined on the basis of experimental results measured using a 5-hole Pitot tube. The calculated damping forces showed good agreement with the corresponding experimental data. The effect of tip clearances on the flutter boundary was also investigated, and it was revealed that the cascade flutter was suppressed owing to the presence of tip clearances. When the blade oscillation was destabilized, it was found that the unsteady aerodynamic force became the exciting force at the blade-tip side sooner than at the hub side. Author

A92-26932*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
SCREECH NOISE SOURCE STRUCTURE OF A SUPERSONIC RECTANGULAR JET
E. J. RICE (NASA, Lewis Research Center, Cleveland, OH) and R. TAGHAVI (NASA, Lewis Research Center, Cleveland; Sverdrup Technology, Inc., Brook Park, OH) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 15 p. Previously announced in STAR as N92-14000. refs
(Contract NAS3-25266)
(AIAA PAPER 92-0503) Copyright
The near-field of the screech noise source structure of an under-expanded supersonic rectangular jet was studied in detail. A miniature probe microphone was used along with a reference microphone to determine the amplitude and phase of the sound pressure near and in the high speed flow field. The transverse structure of the unsteady pressure field was investigated by moving the probe microphone sufficiently far into the jet so that pressure fall-off was observed. Five islands of high sound pressure level have been distinguished which may be associated with the actual local sources of sound production. These sources of screech noise are closely associated with the jet shock structure as would be expected, with the peak region of noise level being found slightly downstream of each of the five observed shocks. The third and fourth noise sources have the highest levels and are about equal in strength. All of the apparent noise sources have their peak levels in the subsonic flow region. Strong cancellations in the acoustic field are observed in the downstream and sideline directions which may account for the predominant upstream propagation of the fundamental tone noise. Author

A92-26943#
NAVIER-STOKES COMPUTATIONS FOR TURBULENT TRANSONIC PROJECTILE WITH A TWO LAYER MODEL COMBINING THE ASM MODEL OF TURBULENCE AND THE K-EPSILON MODEL NEAR THE WALL
CHE-CHUN CHUANG and CHING-CHANG CHIENG (National Tsing Hua University, Hsinchu, Republic of China) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 9 p. refs
(Contract NSCRC-80-0413-E007-11)
(AIAA PAPER 92-0518) Copyright
A two-layer ASM/k-epsilon model of turbulence is adopted to the Reynolds-averaged Navier-Stokes equations, and the numerical computation is successfully performed with reasonable convergence characteristics for turbulent transonic flowfield past a real projectile with a flat base or with a supporting sting. Harten's second order upwind TVD scheme is used to evaluate the convection terms; central difference approximation is applied to calculate viscous terms, and the nonlinear algebraic equations of the algebraic Reynolds stress model are solved by Newton's method. The computed value of the surface pressure coefficients along the projectile surface and the velocity profiles on the boattail are compared, and excellently agree with the experimental data as well as the computed values by the low Reynolds number from k-epsilon model of turbulence. Author

A92-26944#
ANALYSIS OF JUNCTION FLOWFIELDS USING THE INCOMPRESSIBLE NAVIER-STOKES EQUATIONS
BERNARD P. PAUL, JR. and LELAND A. CARLSON (Texas A & M University, College Station) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 20 p. refs
(AIAA PAPER 92-0519) Copyright
The flowfields about the wing-body connection on twin-engined aircraft are modeled analytically with an incompressible 3D Navier-Stokes flow solver for studying junction drag-reduction devices. The Runge-Kutta time-stepping scheme developed by Jameson et al. (1981) is employed in an extended form which incorporates local time stepping, implicit residual averaging, and multigridding. Artificial compressibility is utilized in the model solution to permit the application to incompressible flows, and the solution is tested on a wind-tunnel model and a simplified geometry of the Cougar GA-7 aircraft as well as on the wing-body junction analyzed by Dickinson (1986). The physics of junction flows is simulated effectively, and the numerical results agree with the test-case data from Dickinson's analyses. Flight-test results for the aircraft are shown to agree with the theoretical data suggesting the effectiveness of the present formulation for simplified wing-body junction geometries. C.C.S.

A92-26945#
OBTAINING THE VELOCITY FIELD REQUIRED FOR THE CALCULATION OF PROPELLER UNSTEADY FORCES USING 'TRADITIONAL' APPROXIMATE METHODS AND CFD
T. MAUTNER and M. GILLCRIST (U.S. Navy, Naval Ocean Systems Center, San Diego, CA) AIAA, Aerospace Sciences Meeting and

Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 8 p. Research supported by U.S. Navy. refs
(AIAA PAPER 92-0520)

Traditionally, the calculation of propeller unsteady forces, for noise reduction purposes, involves the use of potential flow and 2D approximate methods. While some success has been achieved using these methods in determining blade skew (sweep) distributions required to reduce unsteady forces, no information can be confidently obtained for vehicle off-design conditions and for inflow modification due to the addition of propulsor blade rows. Thus the need for more sophisticated methods. An existing steady incompressible CFD code has been used to obtain the flow field (Euler) about an axisymmetric body with fins and stator blades. Similar results were obtained from potential flow and Euler calculations, and these results indicate the potential benefit of CFD in obtaining the required velocity data. However, increased grid resolution and viscous computations are necessary to obtain the required boundary layer and turbulence quantities. Author

A92-26946*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

UNSTEADY FLOWFIELD SIMULATION OF DUCTED PROP-FAN CONFIGURATIONS

J. M. JANUS, HOWARD Z. HORSTMAN, and DAVID L. WHITFIELD (Mississippi State University, Mississippi State) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 19 p. refs
(Contract NAG3-767)
(AIAA PAPER 92-0521) Copyright

A technique for the simulation of unsteady flows in and around complex rotating machinery is presented. Additional domain decomposition mechanisms are introduced which extend the range of applicability of software developed for the time-accurate simulation of rotating machinery flowfields. The flow models uses the unsteady 3D Euler equations, discretized as a finite-volume method, utilizing a high-resolution approximate Riemann solver for cell interface flux definitions. Multiblock domain decomposition is used to partition the field radially, axially, as well as circumferentially into an ordered arrangement of blocks which exhibit varying degrees of similarity. A general high-order numerical scheme is applied to satisfy the geometric conservation law. Two configurations are presented - ducted single rotation prop-fan and a rotor-deswirl vane combination which form a single stage fan. Comparisons are made to other numerical solutions for these geometries and to available experimental data. C.A.B.

A92-26947*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

AN UNSTEADY EULER SCHEME FOR THE ANALYSIS OF DUCTED PROPELLERS

R. SRIVASTAVA (NASA, Lewis Research Center, Cleveland; Toledo, University, OH) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 8 p. refs
(Contract NAG3-730)
(AIAA PAPER 92-0522) Copyright

An efficient unsteady solution procedure has been developed for analyzing inviscid unsteady flow past ducted propeller configurations. This scheme is first order accurate in time and second order accurate in space. The solution procedure has been applied to a ducted propeller consisting of an 8-bladed SR7 propeller with a duct of NACA 0003 airfoil cross section around it, operating in a steady axisymmetric flowfield. The variation of elemental blade loading with radius, compares well with other published numerical results. Author

A92-26948*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

CALCULATION OF COMPRESSIBLE BOUNDARY LAYER FLOW ABOUT AIRFOILS BY A FINITE ELEMENT/FINITE DIFFERENCE METHOD

STUART L. STRONG and ANDREW J. MEADE, JR. (Rice University, Houston, TX) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 11 p. refs
(Contract NAG1-1196)
(AIAA PAPER 92-0524) Copyright

Preliminary results are presented of a finite element/finite difference method (semidiscrete Galerkin method) used to calculate compressible boundary layer flow about airfoils, in which the group finite element scheme is applied to the Dorodnitsyn formulation of the boundary layer equations. The semidiscrete Galerkin (SDG) method promises to be fast, accurate and computationally efficient. The SDG method can also be applied to any smoothly connected airfoil shape without modification and possesses the potential capability of calculating boundary layer solutions beyond flow separation. Results are presented for low speed laminar flow past a circular cylinder and past a NACA 0012 airfoil at zero angle of attack at a Mach number of 0.5. Also shown are results for compressible flow past a flat plate for a Mach number range of 0 to 10 and results for incompressible turbulent flow past a flat plate. All numerical solutions assume an attached boundary layer. Author

A92-26957#

FLOW ABOUT CYLINDERS WITH HELICAL SURFACE PROTRUSIONS

J. V. NEBRES and S. M. BATILL (Notre Dame, University, IN) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 12 p. Research supported by U.S. Navy and University of Notre Dame. refs
(AIAA PAPER 92-0540) Copyright

Characteristics of the flow around slender bluff bodies with helical surface protrusions were investigated experimentally in a low speed wind tunnel. Models of yawed stranded cables and cylinders with helical protrusions were tested at the range of Reynolds number of 10,000 to 46,000. A series of measurements were performed using a variety of experimental techniques. Vortex wake formation length was estimated using smoke wire flow visualization and hot wire anemometry. Smoke flow visualization was also used to qualitatively investigate the vortex formation process in the near wake. Surface pressure profile measurements and surface oil flow visualization were conducted to examine the steady lift force development due to yaw. Vortex-induced vibration suppression accomplished by wrapping four helical wires on a circular cylinder was attributed to an elongated vortex formation length. The increased vortex formation length was correlated to periodic spanwise variation in boundary layer separation, shear layer transition, entrainment, diffusion and thickness. In examining the development of steady lift due to yaw, it was determined that the lift force was due to asymmetric separation resulting in asymmetric pressure distributions. Author

A92-26964#

TRANSITION TO TURBULENCE IN CONFINED, COMPRESSIBLE MIXING LAYERS. I - 3D NUMERICAL SIMULATIONS WITH EXCITATION OF RANDOM, BROADBAND WHITE NOISE

H.-S. HUANG and J. J. RILEY (Washington, University, Seattle) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 23 p. Research supported by Johns Hopkins University. refs
(Contract N00014-87-K-0174)
(AIAA PAPER 92-0553) Copyright

Transition in compressible mixing layers is investigated using direct simulations based on a spectral numerical method for solving the fully nonlinear Navier-Stokes equations in conservation form. It is found that a mixing layer subjected to an initial perturbation of broadband white noise grows in the linear regime as predicted by the linear stability theory. For the subsonic convective Mach number 0.50, the mixing layers are 2D-dominant, although 3D effects cannot be neglected when the flow becomes fully nonlinear. For transonic convective Mach number 1.00, the mixing layers initially grow in an oblique, 3D manner, but with 2D acoustic modes. Viscous shocks form in the 3D simulations at supersonic convective Mach number 1.50. These viscous shocks which are caused by

the evolution of supersonic acoustic modes, interact with oblique K-H modes, and develop in a 3D manner. O.G.

A92-26965#

EVALUATION OF SHEAR LAYER CAVITY RESONANCE MECHANISMS BY NUMERICAL SIMULATION

DENNIS F. FUGLSANG and ALAN B. CAIN (McDonnell Aircraft Co., Saint Louis, MO) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 20 p. refs

(AIAA PAPER 92-0555) Copyright

This study addresses the basic mechanisms of the shear layer-cavity acoustic interaction. In particular, the effect of shear layer forcing on the cavity acoustic environment is examined. Time accurate Navier-Stokes simulations were performed for both an unforced and a forced cavity shear layer. The simulations performed without forcing matched existing experimental behavior. The effects of an a priori harmonic forcing intended to break a resonant feedback loop produced surprising results. These include an internal 'self-sustaining of forcing', a chaotic response to harmonic forcing, and an apparent flow 'self-tuning' due to selective shear layer vorticity entrainment into the cavity. An important new insight gained is readjustment of the cavity circulation in the 'self tuning' process. The 'self-tuning' process has shown up in previous experimental work, however, the source of the 'self-tuning' was not identified. The present investigation suggests that it is due to a readjustment of the circulation. Author

A92-26978*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

EXPERIMENTAL RESULTS ON A WALL INTERFERENCE CORRECTION METHOD WITH INTERFACE MEASUREMENTS

C. F. LO and N. ULBRICH (Tennessee, University, Tullahoma) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 12 p. refs

(Contract NAG2-733)

(AIAA PAPER 92-0570) Copyright

A wall interference assessment and correction method for subsonic two-dimensional wind tunnel testing is presented. This method calculates a pressure coefficient and angle of attack correction based on velocity measurements on interfaces inside of the wind tunnel. A mathematical representation of the test article is not required. An experimental verification of the suggested technique is given. A NACA 0012 airfoil is tested at a Mach number of 0.70 and at two different angles of attack. Calculated blockage corrections show reasonable agreement with results based on Hackett's method. Corrected surface pressures compare favorably to free-air flow field data if the tunnel flow field is subsonic. The present wall interference correction method can be applied to transonic tunnel flow fields with some restrictions. Errors are estimated and it is shown that the expected error in calculating the pressure coefficient correction on the model surface is in the order of the error of pressure coefficient measurement on interfaces. Necessary testing equipment in existing tunnels can easily be modified if the present method is applied. Author

A92-26980*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

PLASMADYNAMIC EFFECTS IN THERMOCHEMICAL NONEQUILIBRIUM AEROBRAKE FLOWS

R. A. MITCHELTREE and J. V. SHEBALIN (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 12 p. refs

(AIAA PAPER 92-0573) Copyright

The paper discusses modifications to the governing equations of thermochemical nonequilibrium flow to include plasmadynamic effects. The magnetic field about a 1.1-m nose-radius aerobrake entering the earth's atmosphere at 80-km altitude and traveling 12 km/s is computed. The result of coupling the additional terms into the Langley Aerothermodynamics Upwind Relaxation Algorithm indicate that plasmadynamic effects are negligible for this two-temperature Mars-return aerobraking simulation. By examining the magnitude of the ohmic heating and observing a decrease in this heating when coupling terms are included in the two-temperature solution, it is argued that a three-temperature solution should not produce any different conclusions for aerobraking into the earth's atmosphere. C.A.B.

A92-27010#

HOVER EVALUATION OF AN INTEGRATED PNEUMATIC LIFT/REACTION-DRIVE ROTOR SYSTEM

ALAN W. SCHWARTZ and ERNEST O. ROGERS (U.S. Navy, David W. Taylor Naval Ship Research and Development Center, Bethesda, MD) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 13 p. refs

(AIAA PAPER 92-0630)

An experimental investigation was conducted to examine the aerodynamic properties of an integrated pneumatic lift/reaction-drive rotor system in hover. This advanced rotor concept combines circulation control (CC) aerodynamics and cold-cycle reaction drive technologies into a single system with a common air supply. The primary objective of the experiment was to evaluate the interactions between the lift and drive systems. Internally, energy losses in the blade and drive nozzle affect the drive system efficiency. Simultaneously, the substantial supply flow to the nozzles results in a 'flowing plenum' from which air is drawn for CC. Externally, the proximity of the CC jet sheet and the tip nozzle flow suggests the possibility of mutual interference. Test results reveal a significant impact on induced power efficiency due to the nonlifting tip nozzle region of the blade. The presence of the tip nozzle jet has no discernible impact on the external aerodynamics of the lift system. The measured effective CC jet pressure is reduced according to the static pressure drop caused by the blade duct flow. The combined lift/drive system displays several unique properties including a self-limiting rotation speed and the same linear response of lift to the supply pressure regardless of the control settings and the operating conditions. Author

A92-27011#

A REVIEW OF IMPINGING JETS IN CROSS-FLOWS - EXPERIMENTATION AND COMPUTATION

D. BRAY and K. KNOWLES (Royal Military College of Science, Shrivenham, England) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 11 p. refs

(AIAA PAPER 92-0633) Copyright

A review of research work in the flowfield associated with an impinging jet (or jets) in a crossfield is presented. All of the more relevant results have been assembled to provide an overall up-to-date picture of this research. Numerical modeling has been demonstrated to be possible to simulate the principal features of a ground vortex. A number of the observed parametric trends may also be replicated to a reasonably accurate degree. R.E.P.

A92-27012#

MEASUREMENTS OF THE INFLOW TO A VIBRATING ROTOR BLADE

S.-G. LIOU and N. M. KOMERATH (Georgia Institute of Technology, Atlanta) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 13 p. Research supported by U.S. Army. refs

(AIAA PAPER 92-0634) Copyright

The inflow to a two-bladed rotor in hover is measured using a laser velocimeter, first under steady conditions, and then under prescribed 4-per-rev periodic pitch excitation. This experiment requires high data rates, and new data acquisition techniques, which have been demonstrated. The data rate and quality permit extraction of velocity variations over a single period of rotor revolution. The steady case results agree well with lifting-line-based analytical predictions except in the tip region, as expected. The excited-blade case shows the 4-per rev velocity perturbation, and the expected dependence on the phase of the excitation. Spectral analysis of the LDV data has been successfully demonstrated, and shows multiple harmonics of the excitation frequency. Substantial hysteresis is seen in the response of the flowfield to the pitch variation, even with the small amplitude of pitch change. These effects vary along the radius. Author

A92-27013#
NUMERICAL SIMULATION OF FLOW SEPARATION FOR ROTORS AND FIXED WINGS
FU-LIN TSUNG and LAKSHMI N. SANKAR (Georgia Institute of Technology, Atlanta) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 11 p. refs
(Contract DAAG29-88-C-0003)
(AIAA PAPER 92-0635) Copyright

This research deals with the effects of rotational forces on flow separation over rotors of a given planform. Navier-Stokes solutions of flowfields for a rotor blade operating both in rotary- and fixed-wing mode at three different angle sittings have been calculated. Results from the computation show that the effects of centrifugal and Coriolis forces are more pronounced at high angles of operation. These forces have a beneficial influence with respect to separation; the stall angle for the rotor is increased by at least 5 deg when compared with the fixed-wing. Author

A92-27014# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
CROSSING SHOCK WAVE TURBULENT BOUNDARY LAYER INTERACTIONS - VARIABLE ANGLE AND SHOCK GENERATOR LENGTH GEOMETRY EFFECTS AT MACH 3
S. M. BOGDONOFF and W. L. STOKES (Princeton University, NJ) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 21 p. Research supported by USAF. refs
(Contract NAG2-718)
(AIAA PAPER 92-0636) Copyright

By comparing the detailed wall static pressure distributions for 9 inch and 11 inch long fins generating a crossing shock configuration at M = 2.93, the high resolution results of the 9 inch fins are shown to be free of exit effects. Analysis of the static pressure profiles have delineated the limited regions where the single fin results are valid. The characteristics of the complex interaction, with varying shock wave strength, have been described. The data provide a critical test for computational fluid dynamics which, in its initial phase, has performed poorly in predicting the measured wall static pressure distributions. Author

A92-27016*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EFFECTS OF NOSE BLUNTNESS AND ANGLE OF ATTACK ON SLENDER BODIES IN HYPERSONIC FLOWS
S. N. TIWARI, A. K. SEHGAL (Old Dominion University, Norfolk, VA), and D. J. SINGH (Analytical Services and Materials, Inc., Hampton, VA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 26 p. refs
(Contract NCC1-68; NAG1-363; NAG1-423)
(AIAA PAPER 92-0638) Copyright

The effects of angle of attack and nose bluntness on the flow field and wall quantities are investigated for hypersonic flows of air over slender bodies. The bodies considered are slender cones and straight biconic configurations. The numerical procedures used are based on the solution of complete Navier-Stokes equations in the nose region and parabolized Navier-Stokes equations in the downstream region. Results are obtained for a wide range of free stream conditions in which the gas behind the shock is treated as perfect. The flow field variables and surface quantities show significant differences when the angle of attack and nose bluntness are varied. The postshock flow field is studied in detail from the contour plots of Mach number, density, and temperature. Flow separation is observed on the leeward plane for an on-axis, 12.84 deg/7 deg (fore-cone and aft-cone angles) biconic geometry at 12 deg angle of attack. Also, the windward and leeward heating rates for the fore-cone section decrease by a factor of four and five, respectively, when the nose bluntness is increased by an order of magnitude. The effect of nose bluntness for slender cone persists as far as 200 nose radii downstream. Author

A92-27017#
NUMERICAL INVESTIGATION OF A TRANSVERSE JET FOR SUPERSONIC AERODYNAMIC CONTROL
STEVEN W. CLARK and STEPHEN C. CHAN (Teledyne Brown Engineering, Huntsville, AL) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 11 p. refs
(AIAA PAPER 92-0639) Copyright

This paper initially addresses some concerns associated with properly validating a CFD code. Experimental data are used from a sonic jet injecting perpendicular into supersonic flow over a flat plate. A grid sensitivity study is shown to be absolutely essential for code validation. Only then can a numerical parametric study result in a successful control system design. Specifically, streamwise nodes were increased until a grid independent solution was found. The final surface pressure distribution results compare very well with experimental data, especially in predicting the location of the upstream boundary layer separation point. A combination of upstream sonic injection and reduced mass flow rate is shown to produce essentially the same force as the normal sonic injection at higher flow rates. Author

A92-27021*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
RESULTS OF AN ICING TEST ON A NACA 0012 AIRFOIL IN THE NASA LEWIS ICING RESEARCH TUNNEL
JAIWON SHIN and THOMAS H. BOND (NASA, Lewis Research Center, Clevelend, OH) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 20 p. Previously announced in STAR as N92-15051. refs
(AIAA PAPER 92-0647) Copyright

Tests were conducted in the Icing Research Tunnel (IRT) at the NASA Lewis Research Center to document the current capability of the IRT, focused mainly on the repeatability of the ice shape over a range of icing conditions. Measurements of drag increase due to the ice accretion were also made to document the repeatability of drag. Surface temperatures of the model were obtained to show the effects of latent-heat release by the freezing droplets and heat transfer through the ice layer. The repeatability of the ice shape was very good at low temperatures, but only fair at near freezing temperatures. In general, drag data shows good repeatability. Author

A92-27023*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
MULTIBODY INTERFERENCE AT TRANSONIC MACH NUMBERS
GARY T. CHAPMAN, WILLIAM K. BONNESS (California, University, Berkeley), and PRISCA L. LYNCH (USAF, Armament Directorate, Eglin AFB, FL) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 17 p. refs
(Contract NCA2-529)
(AIAA PAPER 92-0651)

An experimental and computational study has been made of the forces and moments on multibody configurations at Mach numbers from 0.6 to 1.2. The interference forces and moments that occur on symmetric double and triple body configurations at zero angle of attack are examined in detail. In all cases, the normal interference force is always in a direction to pull the bodies together and the moment about the 0.5L point is always to rotate the tips of the bodies away from the center of the configuration. The axial interference force (pressure drag at zero angle of attack) increases the drag per store as additional stores are added to the configuration. The effect of angle of attack on the interference is relatively small. Author

A92-27031*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AN ANALYTICAL APPROACH TO GRID SENSITIVITY ANALYSIS
IDEEN SADREHAGHIGHI (Old Dominion University, Norfolk, VA), ROBERT E. SMITH (NASA, Langley Research Center, Hampton, VA), and SURENDRA N. TIWARI (Old Dominion University, Norfolk, VA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 12 p. refs
(AIAA PAPER 92-0660)

Sensitivity analysis in Computational Fluid Dynamics with

emphasis on grids and surface parameterization is described. An interactive algebraic grid-generation technique is employed to generate C-type grids around NACA four-digit wing sections. An analytical procedure is developed for calculating grid sensitivity with respect to design parameters of a wing section. A comparison of the sensitivity with that obtained using a finite-difference approach is made. Grid sensitivity with respect to grid parameters, such as grid-stretching coefficients, are also investigated. Using the resultant grid sensitivity, aerodynamic sensitivity is obtained using the compressible two-dimensional thin-layer Navier-Stokes equations. Author

A92-27036#
A DEFORMING GRID VARIATIONAL PRINCIPLE AND FINITE ELEMENT METHOD FOR COMPUTING UNSTEADY SMALL DISTURBANCE FLOWS IN CASCADES
KENNETH C. HALL (Duke University, Durham, NC) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 12 p. refs
(AIAA PAPER 92-0665) Copyright
A variational method for computing unsteady subsonic flows in turbomachinery blade rows is presented. A variational principle which describes the harmonic small disturbance behavior of the full potential equations about a nonlinear mean flow is developed. Included in this variational principle is the effect of a deforming computational grid which conforms to the motion of vibrating airfoils. A finite element method is used to discretize the variational principle, and the resulting discretized equations are solved efficiently using LU decomposition. The advantage of using a deforming computational grid is that the accuracy of the method is dramatically improved since no extrapolation is required to apply the upwash boundary conditions or to evaluate the unsteady pressure on the airfoil surfaces. Furthermore, airfoil motions with chordwise bending are easily analyzed. Results computed using this technique are presented and compared to experimental data and other analytical and computational methods. Author

A92-27088#
ON HYPERSONIC BOUNDARY-LAYER STABILITY
KENNETH F. STETSON and ROGER L. KIMMEL (USAF, Wright Laboratory, Wright-Patterson AFB, OH) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 61 p. refs
(AIAA PAPER 92-0737)
Experimental hypersonic boundary-layer stability results obtained using hot-wire anemometry techniques are reviewed. Data are obtained at a freestream Mach number of 8 on water-cooled and uncooled 7-degree half-angle cones and on a water-cooled cylinder. A unique feature of a hypersonic boundary layer is the presence of the high instability modes, the Mack modes. These instabilities produce high frequency, large amplitude density fluctuations which can dominate the transition process. It is shown that hypersonic trends are different from lower Mach number trends. For example, cooling the surface stabilizes low Mach number boundary layers, but can destabilize a hypersonic boundary layer. Many parametric effects are found to be very sensitive to Mach number. A small nose-tip bluntness can completely dominate the stability of a hypersonic boundary layer, resulting in very large critical Reynolds numbers. O.G.

A92-27092#
HOLOGRAPHIC FLOWFIELD DENSITY MEASUREMENTS IN SWEPT SHOCK WAVE/BOUNDARY-LAYER INTERACTIONS
J. C. HSU and G. S. SETTLES (Pennsylvania State University, University Park) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 12 p. refs
(Contract AF-AFOSR-86-0082; AF-AFOSR-89-0315)
(AIAA PAPER 92-0746) Copyright
This flowfield structures and quantitative density distributions of swept shock wave/turbulent boundary layer interactions have been imaged and measured by holographic interferometry. Quasi-conical swept interactions were generated by a sharp fin at angle-of-attack mounted on a flat plate. The six interactions studied range from a weak case at Mach 2.35, alpha = 7 deg to a very strong case at Mach 3.93, alpha = 25 deg. A conical holographic object beam, focused at the virtual origin of the interaction and aimed along the swept shock wave, was used to produce double-pulse holographic interferograms of the interaction flowfields. These interferograms were analyzed to yield flowfield density maps in the crossflow plane. These data are believed to be the first quantitative, nonintrusive flowfield data ever obtained in a swept shock/boundary layer interaction. Comparisons are made with previous experimental and computational results. Author

A92-27093# National Aeronautics and Space Administration, Washington, DC.
AN EXPERIMENTAL/COMPUTATIONAL STUDY OF SHARP FIN INDUCED SHOCK WAVE/TURBULENT BOUNDARY LAYER INTERACTIONS AT MACH 5 - EXPERIMENTAL RESULTS
PATRICK E. RODI and DAVID S. DOLLING (Texas, University, Austin) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 17 p. Research supported by NASA, USAF, and U.S. Navy. refs
(Contract NGT-50172)
(AIAA PAPER 92-0749) Copyright
A combined experimental/computational study has been performed of sharp fin induced shock wave/turbulent boundary layer interactions at Mach 5. The current paper focuses on the experiments and analysis of the results. The experimental data include mean surface heat transfer, mean surface pressure distributions and surface flow visualization for fin angles of attack of 6, 8, 10, 12, 14 and 16-degrees at Mach 5 under a moderately cooled wall condition. Comparisons between the results and correlations developed earlier show that Scuderi's correlation for the upstream influence angle (recast in a conical form) is superior to other such correlations in predicting the current results, that normal Mach number based correlations for peak pressure heat transfer are adequate and that the initial heat transfer peak can be predicted using pressure-interaction theory. Author

A92-27094#
FLOWFIELD VISUALIZATION OF CROSSING SHOCK-WAVE/BOUNDARY-LAYER INTERACTIONS
T. J. GARRISON and G. S. SETTLES (Pennsylvania State University, University Park) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 11 p. refs
(Contract AF-AFOSR-89-0315)
(AIAA PAPER 92-0750) Copyright
The flowfield structure of symmetric crossing-shock/turbulent boundary-layer interactions is examined experimentally for the first time, using the planar laser scattering (PLS) technique. The nature of the viscous region, the overlying shock structure, and the interaction footprint are studied. A complex reflected shock system and a mushroom-shaped pair of separation vortices result from the confluence of the two fin-generated interactions which make up this flow. The resulting viscous region occupies a significant portion of the outflow from the dual-fin test geometry. This has significant implications for the use of sidewall compression in high-speed inlets. Author

A92-27095#
NUMERICAL ANALYSIS OF SHOCK-INDUCED SEPARATION ALLEVIATION USING VORTEX GENERATORS
JON S. MOUNTS and THOMAS J. BARBER (United Technologies Research Center, East Hartford, CT) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 12 p. refs
(AIAA PAPER 92-0751) Copyright
A 3D, multiblock, multizone Euler/Navier-Stokes algorithm was used to analyze the flowfield over a lateral cascade of vortex generation (VG) devices, 2D shock/boundary layer interaction (SBLI), and 3D SBLI separation alleviation. The VG devices entrain the high momentum flow from the upper region of the boundary layer into the lower momentum flow region near the surface, allowing the boundary layer flow to minimize the effect of the imposed adverse pressure gradient due to a normal shock and

alleviating any shock-induced regions of a separated flow. The alleviation occurs when the VG devices are located at a distance upstream of the shock which allows the generated streamwise vortices ample time to energize the low momentum boundary layer flow near the surface. Data obtained reveal a reduction of the reverse flow region at the point of separation, in the height of the reverse flow bubble, and a dramatic reduction in the downstream extent of the reattachment point. O.G.

A92-27097#

FINITE-ELEMENT ALGORITHM FOR CHEMICALLY REACTING HYPERSONIC FLOW

E. LAURIEN, M. BOEHLE, H. HOLTHOFF, J. WIESBAUM, and A. LIESEBERG (Braunschweig, Technische Universitaet, Brunswick, Federal Republic of Germany) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 14 p. refs

(AIAA PAPER 92-0754) Copyright

The development of a 2D and 3D numerical simulation algorithm for engineering computations of hypersonic chemically reacting flows is outlined. The method is based on the Taylor-Galerkin finite-element method in connection with unstructured triangular and tetrahedral grids and high resolution shock-capturing. The aim of this work is an accurate and efficient prediction of flows near the heat shield of reentry capsules or vehicles, and through engine inlets. The present paper gives an overview of the numerical algorithm and presents various model cases. A blunted wedge under reentry conditions and a model inlet and a generic forebody at hypersonic cruise are investigated. Author

A92-27098#

COMPUTATION OF LAMINAR FLOW OVER A LONG SLENDER AXISYMMETRIC BLUNTED CONE IN HYPERSONIC FLOW

V. ESFAHANIAN (DynaFlow, Inc., Columbus, OH), TH. HERBERT, and O. R. BURGGRAF (Ohio State University, Columbus) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 12 p. refs

(Contract F49620-88-C-0082)

(AIAA PAPER 92-0756) Copyright

An accurate laminar flow over a long axisymmetric 7-deg half-angle blunt cone at freestream $M = 8$ is computed. The flow field is obtained by solving the thin-layer Navier-Stokes equations, using the Beam and Warming method. The results of the present computation are compared to those of the Stetson et al. (1984) experiment. The computation is intended to establish a benchmark solution for code development and a reliable basic flow for flow stability analysis of the flow in the experiment of Stetson et al. Author

A92-27099#

COMPRESSIBLE LAMINAR BOUNDARY LAYERS FOR PERFECT AND REAL GASES IN EQUILIBRIUM AT MACH NUMBERS TO 30

AUGUSTO C. M. MORAES, JOSEPH E. FLAHERTY, and HENRY T. NAGAMATSU (Rensselaer Polytechnic Institute, Troy, NY) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 14 p. Research supported by Rennselaer Polytechnic Institute and SDIO. refs

(Contract DAAL03-90-G-0096)

(AIAA PAPER 92-0757) Copyright

Laminar boundary layers at Mach numbers up to 30 and stagnation temperatures up to 8000 K are investigated under the National Aero-Space Plane project. A finite element method with symbolic evaluation of element matrices was used to solve the Prandtl laminar boundary layer equations for an adiabatic flat plate. Three different cases under consideration include a perfect gas with constant properties and unit Prandtl number; a perfect gas with viscosity and thermal conductivity variation according to Sutherland's law; and a real gas with equilibrium air properties. Each flow regime is characterized in terms of streamwise and transverse velocity profiles, temperature, and density distributions. O.G.

A92-27381

A STUDY ON THE SUPERCONVERGENCE OF MULTHOPP'S DISCRETIZATION IN VORTEX-LATTICE METHODS

KE-QIN ZHU (Max-Planck-Institut fuer Stroemungsforschung, Goettingen, Federal Republic of Germany) Fluid Dynamics Research (ISSN 0169-5983), vol. 9, Jan. 1992, p. 73-79. refs

Copyright

An earlier proof of the superconvergence of Multhopp's discretization for the flow past a two-dimensional flat plate showed the potentiality of an optimal discretization scheme for vortex-lattice methods. The study of the superconvergence of Multhopp's discretization is extended to the more complicated flow past a thin airfoil, with camber line represented by a polynomial of degree 4. The approach is based on an error analysis. It is shown that the numerical solution for the vorticity density on the camber line is in complete agreement with the exact solution when a Multhopp discretization is used; the lift and pitching moment are also exact. To obtain this kind of high accuracy, the only limitation is that the number of the elements used is greater than 2. Author

A92-27384

BOUNDARY SINGULARITIES IN STEADY POTENTIAL COMPRESSIBLE FLOW THROUGH PLANE TWO-DIMENSIONAL CHANNELS

C. A. C. STREETER Institution of Mechanical Engineers, Proceedings, Part C - Journal of Mechanical Engineering Science (ISSN 0954-4062), vol. 205, no. C6, 1991, p. 389-398. refs

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The physical and hodograph plane representations of the steady potential flow of a perfect gas through two-dimensional channels are examined with emphasis on the solution of boundary singularities that occur in these flows. Two channel geometries are considered: (1) straight-walled convergent channels of infinite and finite length and (2) finite-length channels with a parallel entry section and a straight-walled convergent exit section. Radial source flow and concave corner flow singularities occurring in the physical plane of subsonic channel flow are removed by expressing the general solution of Chaplygin's stream function equation in hodograph coordinates. A boundary singularity in the hodograph plane is removed by introducing circular polar coordinates. The problem of matching the subsonic and supersonic flow regions at the sonic surface is also analyzed. V.L.

A92-27531

HYPERSONIC FLOW OF A VISCOUS GAS PAST SHARP ELLIPTICAL CONES AT ANGLES OF ATTACK AND SLIP [OBTEKANIE OSTRYKH ELLIPTICHESKIKH KONUSOV GIPERZVUKOVYM POTOKOM VIAZKOGO GAZA POD UGLAMI ATAKI I SKOL'ZHENIIA]

A. A. LEGOSTAEV and S. V. PEIGIN (NII Prikladnoi Matematiki i Mekhaniki, Tomsk, USSR) Teplofizika Vysokikh Temperatur (ISSN 0040-3644), vol. 29, Nov.-Dec. 1991, p. 1157-1163. In Russian. refs

Copyright

The problem of hypersonic flow of a viscous heat-conducting ideal gas past sharp elliptical cones at angles of attack and slip is analyzed using a model of a thin viscous shock layer. A numerical solution to the problem is obtained over a wide range of cone shapes, angles of attack and slip, and flow regimes in the shock layer. It is shown that the Reynolds number can be eliminated as a determining parameter of the problem through the transformation of variables. The shock layer structure, heat flows, and friction coefficients on the cone surface are investigated as a function of the flow geometry. V.L.

A92-27532

CALCULATION OF HEAT TRANSFER AND FRICTION FOR A BLUNT BODY IN THE PATH OF SUPERSONIC FLOW OF A CHEMICALLY EQUILIBRIUM AIR-XENON MIXTURE [RASCHET TEPLOOBMENA I TRENIIA ZATUPLENNOGO TELA PRI SVERKHZVUKOVOM OBTEKANII KHIMICHESKI RAVNOVESNOI SMES'IU VOZDUKHA S KSENONOM]

O. V. ZVEREV and N. N. PILIUGIN (Moskovskii Gosudarstvennyi

Universitet, Moscow, USSR) Teplofizika Vysokikh Temperatur (ISSN 0040-3644), vol. 29, Nov.-Dec. 1991, p. 1164-1170. In Russian. refs
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The flow parameters of an equilibrium reacting three-element air-xenon mixture are investigated numerically. In particular, attention is given to the effect of the diffusion of the elements on friction and convective heat transfer toward the body surface. The convective heat transfer toward the body surface and the integral spectral radiation of the shock layer are determined as a function of xenon concentration in the mixture. An expression is proposed for calculating the convective heat flow as a function of xenon concentration. V.L.

A92-27533
RADIANT HEAT TRANSFER IN SUPERSONIC THREE-DIMENSIONAL AND AXISYMMETRIC FLOW OF AIR PAST EVAPORATING BODIES [LUCHISTYI TEPLOOBMEN PRI SVERKHZVUKOVOM PROSTRANSTVENNOM I OSESIMMETRICHNOM OBTEKANII ISPARIAIUSHCHIKHSIA TEL VOZDUKHOM]
E. Z. APSHTEIN, V. I. SAKHAROV, and A. V. SHEVOROSHKIN (Moskovskii Gosudarstvennyi Universitet, Moscow, USSR) Teplofizika Vysokikh Temperatur (ISSN 0040-3644), vol. 29, Nov.-Dec. 1991, p. 1178-1183. In Russian. refs
Copyright
Supersonic flow of an ideal gas past bodies of various shapes (e.g., spheres, axisymmetric ellipsoids, and three-dimensional triaxial ellipsoids) is investigated numerically with allowance for injection from the surface. The effect of the screening by material vapors (modeled by air) on the distribution of relative radiant heat flows on the body surface is analyzed. It is shown that the distributions of relative radiant heat flows in the axisymmetric case are similar to the corresponding curves calculated without allowance for injection. V.L.

A92-27537
A METHOD FOR THE OPTICAL MEASUREMENT OF SURFACE FRICTION IN SUPERSONIC FLOW [K METODIKE IZMERENIIA POVERKHNOSTNOGO TRENIIA OPTICHESKIM METODOM V SVERKHZVUKOVOM POTOKE]
V. I. KORNILOV, A. A. PAVLOV, and S. I. SHPAK (AN SSSR, Institut Teoreticheskoi i Prikladnoi Mekhaniki, Novosibirsk, USSR) Sibirskii Fiziko-Tekhnicheskii Zhurnal (ISSN 0869-1339), Nov.-Dec. 1991, p. 47-51. In Russian. refs
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An attempt was made to use a single-beam optical scheme using a He-Ne laser for measuring surface friction in superosnic flow. The measurements were carried out on the side wall of the test section of a wind tunnel under conditions of essentially gradient-free flow at Mach 3.0 +/- 0.01 and Reynolds numbers of (1.16-3.92) x 10 exp 5. The results are found to agree with those obtained by the Spalding-Chi method to within 10 percent. V.L.

A92-27593
CALCULATION OF THREE-DIMENSIONAL FLOW PAST BLUNT CONES NEAR THE PLANE OF SYMMETRY FOR DIFFERENT FLOW REGIMES IN THE SHOCK LAYER AND IN THE PRESENCE OF GAS INJECTION FROM THE SURFACE [RASCHET PROSTRANSTVENNOGO OBTEKANIIA SFERICHESKI ZATUPLENNYKH KONUSOV V OKRESTNOSTI PLOSKOSTI SIMMETRII PRI RAZLICHNYKH REZHIMAKH TECHENIIA V UDARNOM SLOE I VDUVE GAZA S POVERKHNOSTI]
A. V. BUREEV and V. I. ZINCHENKO PMTF - Prikladnaia Mekhanika i Tekhnicheskaia Fizika (ISSN 0044-4626), Nov.-Dec. 1991, p. 72-78. In Russian. refs
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Based on a model of an integral viscous shock layer in the vicinity of the flow plane of symmetry, three-dimensional flow past a blunt cone with a spherical nose section is investigated over a wide range of Reynolds numbers for various flow regimes in the shock layer. The analysis uses a series truncation procedure. The effects of the angle of attack, conicity, and flow rate and distribution of gas injected through the porous spherical shell on the heat transfer characteristics are determined. V.L.

A92-27594
EFFECT OF RAREFACTION ON THE NONSTATIONARY INTERACTION OF A SUPERSONIC UNDEREXPANDED JET WITH A PERPENDICULAR OBSTACLE [VLIIANIE RAZREZHENNOSTI NA PROTSESS NESTATSIONARNOGO VZAIMODEISTVIIA SVERKHZVUKOVOI NEDORASSHIRENNOI STRUI S PERPENDIKULIARNOI PREGRADOI]
A. V. SAVIN, E. I. SOKOLOV, V. S. FAVORSKII, and I. V. SHATALOV PMTF - Prikladnaia Mekhanika i Tekhnicheskaia Fizika (ISSN 0044-4626), Nov.-Dec. 1991, p. 78-83. In Russian. refs
Copyright
The effect of viscosity on the nonstationary interaction of a supersonic underexpanded fluid jet with an obstacle was investigated experimentally in a vacuum chamber (10,000-100 Pa) using air and helium at 293 K as the working gases. Pressure fluctuations at the obstacle were monitored by means of compact (1.5 mm in diameter) piezoceramic sensors; acoustic radiation was measured by means of an electrodynamic microphone. An analysis of the results obtained suggests that the presence of nonstationary regimes is associated with the presence of a shock wave jet structure and its transformation with a change in the rarefaction parameter. Experimental data are presented in graphic form. V.L.

A92-27596
EVOLUTION OF PERTURBATIONS IN A SUPERSONIC BOUNDARY LAYER [O RAZVITII VOZMUSHCHENII V SVERKHZVUKOVOM POGRANICHNOM SLOE]
S. A. GAPONOV PMTF - Prikladnaia Mekhanika i Tekhnicheskaia Fizika (ISSN 0044-4626), Nov.-Dec. 1991, p. 98-101. In Russian. refs
Copyright
The evolution of perturbations in a supersonic boundary layer is investigated theoretically in the light of new experimental data. The stability of a supersonic boundary layer of a flat plate is analyzed in the approximation of parallel flow and with allowance for the nonparallel nature of the flow. It is shown, in particular, that the boundary layer may contain stationary waves corresponding to modes 1 and 3. Mode 2 is shown to attenuate in a relaxation manner upstream as the circular frequency tends to zero. V.L.

A92-27597
CHARACTERISTICS OF THE MECHANISM OF SEPARATED FLOW PULSATION AHEAD OF A SPIKE-TIPPED CYLINDER IN SUPERSONIC FLOW [OSOBENNOSTI MEKHANIZMA PUL'SATSII OTRYVNOGO TECHENIIA PERED TSILINDROM S OSTROI IGLOI PRI SVERKHZVUKOVOM OBTEKANII]
V. I. ZAPRIAGAEV and S. G. MIRONOV PMTF - Prikladnaia Mekhanika i Tekhnicheskaia Fizika (ISSN 0044-4626), Nov.-Dec. 1991, p. 101-108. In Russian. refs
Copyright
The mechanism and characteristics of separated flow pulsation ahead of a spike-tipped cylinder in supersonic flow are examined with reference to experimental data obtained by the schlieren photography method. An analysis of schlieren photographs shows that the relation between the position of the head shock wave and the pressure pulsation phase for aperiodic pulsations is generally similar to that observed in the case of developed self-oscillations. The onset of aperiodic pulsations is attributed to the fact that the small extension of the spike beyond the shock wave leads to stability loss in the oscillatory system while efficient feedback is not yet established. The impulse nature of the onset of intense pulsations at the boundary of the region of their existence provides evidence of the relaxation origin of the self-oscillations. V.L.

A92-27645

DETERMINATION OF DUTY FACTORS FROM EXPERIMENTAL DATA IN LOCAL INTERACTION THEORY [O NAKHOZHDENII KOEFFITSIENTOV REZHIMA PO EKSPERIMENTAL'NYM DANNYM V TEORII LOKAL'NOGO VZAIMODEISTVIIA]

I. A. KHALIDOV Leningradskii Universitet, Vestnik, Matematika, Mekhanika, Astronomiia (ISSN 0024-0850), July 1991, p. 88-91. In Russian. refs

Copyright

The difficulties associated with the determination of duty factors from experimental data are briefly reviewed, and an approach to the determination of duty factors for bodies of revolution is proposed which is based on the expansion of the reference function and aerodynamic coefficients into a natural series in Legendre polynomials. A criterion is obtained for selecting the shape of bodies in such a way as to increase the accuracy in determining the duty factors from the specified values of the aerodynamic coefficients of bodies of revolution. V.L.

A92-27801

THREE-DIMENSIONAL COMPRESSIBLE FLOWS IN TURBO-MACHINERY SOLVED BY THE PSEUDOSTREAM FUNCTION FORMULATION

CHUNWEI GU, JIANZHONG XU (Chinese Academy of Sciences, Institute of Engineering Thermophysics, Beijing, People's Republic of China), and JUN LU (Petroleum Institute, Beijing, People's Republic of China) Journal of Engineering Thermophysics (ISSN 0253-231X), vol. 12, Nov. 1991, p. 361-366. In Chinese. refs

By theoretically comparing the pseudostream functions with the stream functions and streamlike functions it is indicated that the pseudostream function method has some advantage in solving a 3D flow field. In the transonic case the momentum equation which has not been used as the principal equations of pseudostream functions is employed to calculate the density to make a unique density determination. The numerical examples show that the method is simple and effective for solving subsonic and transonic flow. Author

A92-27802

LOSS PREDICTION OF ANNULAR CASCADE FLOW BASED UPON S1/S2 STREAM SURFACE NAVIER-STOKES ANALYSIS

PANMING LU (University of Science and Technology of China, Hefei, People's Republic of China) Journal of Engineering Thermophysics (ISSN 0253-231X), vol. 12, Nov. 1991, p. 367-372. In Chinese. refs

The overall performance of a VKI annular turbine cascade is numerically predicted based upon 2D Si and S2 stream surfaces entropy-linked ensemble-averaged full Navier-Stokes analysis. The increased rate of the mass-averaged total pressure loss within and downstream the cascade agrees with the experimental data very well. The method can potentially be used in engineering and design. Author

A92-27803

A NEW CALCULATING METHOD FOR THE FLOWFIELD IN TURBOMACHINERY - THE STUDY ON THE APPLICATION OF THE VORTICITY-VELOCITY EQUATIONS FOR THE NUMERICAL SOLUTION OF THE FLOWFIELD IN TURBOMACHINERY

CHUN LI, ZHONGQI WANG, and GUOTAI FENG (Harbin Institute of Technology, People's Republic of China) Journal of Engineering Thermophysics (ISSN 0253-231X), vol. 12, Nov. 1991, p. 373-377. In Chinese. refs

Based on the vorticity-velocity formulation of the Navier-Stokes equations a method for calculating the flowfield in turbomachinery is proposed which is suitable for both inertial and noninertial coordinates. The vorticity-velocity equations in the noninertial coordinates are derived as are the expansions in arbitrary nonorthogonal curvilinear coordinates. The aforementioned equations have the same form both in the inertial and the noninertial coordinates. It is shown that the noninertial effects only enter into the solution of the problem through the implementation of the initial and boundary conditions. This method greatly simplifies the solution for the flowfield of turbomachinery with complicated geometrical domains. Author

A92-27827

A NUMERICAL METHOD FOR ANALYZING THE NONLINEAR FLUTTER OF WINGS AT HIGH ANGLES OF ATTACK

ZHENGYIN YE and LINGCHENG ZHAO (Northwestern Polytechnical University, Xian, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, Oct. 1991, p. B459-B463. In Chinese. refs

A numerical technique is presented for analyzing the nonlinear flutter characteristics of wings with separation at high angles of attack. To determine the ratios between the amplitudes of different modes, an iterative technique is introduced. The numerical results show that the critical flutter speed of the wings decreases when the angle of attack increases, and the results are in agreement with those of the time integration method and experimental data. R.E.P.

A92-27828

INVESTIGATION ON VORTEX CONTROL TECHNIQUE OF FLOW SEPARATION IN DIFFUSER

XIJUN HUANG, JINZHONG DONG, and CHENGSHU XIAO (Beijing University of Aeronautics and Astronautics, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, Oct. 1991, p. B464-B469. In Chinese. refs

Flow separation in a diffuser with a large divergence angle seriously affects the performance and flow distortion of the diffuser. The vortex-control technique is used for suppressing the diffuser-flow separation. The designed vortex trap on the diffuser wall changes the velocity distribution and increases the momentum of the boundary layer near the diffuser wall. The effect of the configuration of the vortex trap on the suppression of separation is described. Based on the measured parameters of diffuser flow the mechanism of the vortex-control technique is also discussed. Author

A92-27829

SEPARATION CONTROL BY VORTEX GENERATORS IN SUBSONIC DIFFUSER

LIANGWEI FANG and XIAO CHEN (Nanjing Aeronautical Institute, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, Oct. 1991, p. B470-B475. In Chinese. refs

An experimental study of separation control by the vortex generators in a subsonic diffuser has been performed. High efficiency of the utilization of vortex generators to control the flow separation in the diffuser can be achieved if the geometrical parameters, the configuration, and the installed location of the vortex generators are carefully selected. R.E.P.

A92-27831

THE COMPUTATION OF TRANSONIC VISCOUS FLOW

ZIQIANG ZHU, XIA MA, and BINGYONG CHEN (Beijing University of Aeronautics and Astronautics, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, Oct. 1991, p. B483-B493. In Chinese. refs

A transonic viscous-flow computational method is described by using viscous/inviscid interaction technique. A shock-point operator is introduced to account for the entropy change across the shock and a nonisentropic full-potential method is formulated to allow a more accurate inviscid flow computation. A streamwise velocity profile is proposed. Based on this profile and other auxiliary relationships, a 3D inverse integral compressible turbulent boundary layer method is formulated. The inviscid and viscous solution are coupled with semiinverse scheme. The numerical results show that this viscous/inviscid interaction method is in good agreement with experimental data and requires less computer resources. Author

A92-27833
THE DIMENSIONAL RECONSTRUCTION OF VORTEX CROSS-SECTION IMAGES
ZHAOWEN ZHANG, LIMIN CHANG, JINSEN HONG, and GANG NI (Beijing Institute of Aerodynamics, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, Oct. 1991, p. B503-B506. In Chinese. refs

The problems of 3D vortex reconstruction by means of vortex cross-section visualization obtained with a laser sheet is discussed. It includes the cross-section sampling methods, digital image processing, 3D display, and reconstruction algorithms. A 3D representation of the vortex field is obtained by stacking the contours in sequence with a constant separation distance between cross-sectional planes. The topological features of the spatial construction of vortex can be comprehended from this display of perspective projections. The multiple directional 3D staircase surface vortex representations are given, and the experimental model is a delta wing with flap in transonic wind tunnel. Author

A92-27851
NUMERICAL SIMULATION OF THE FLOW AROUND RECTANGULAR CYLINDER
DEXUN FU, YANWEN MA (Chinese Academy of Sciences, Institute of Mechanics, Beijing, People's Republic of China), and LI WANG (Beijing Institute of Aerodynamics, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, Sept. 1991, p. A439-A443. In Chinese. refs

The viscous flow around a rectangular cylinder is simulated by solving the 2D compressible Navier-Stokes equations. The partial differential equations are approximated by difference methods such as the Jacobian matrix-splitting technique and approximate factorization. The scheme has second-order accuracy in space and time. The Mach number 0.3 and the Reynolds number 20,000 are used in the computation. The unsteady Karman vortex separation and asymmetry of pair of vortices can be seen clearly from the computed results. The old vortices are moved downstream and the new ones are generated from the corner of the cylinder. The influence of compressibility on vortex formation is considered. The critical Reynolds number increases with the Mach number. Author

A92-27905
THE UNSTEADY FLOW CHARACTERISTICS OF AN S-SHAPED INLET AT HIGH INCIDENCE
QI LIN (Xiamen University, People's Republic of China) and RONGWEI GUO (Nanjing Aeronautical Institute, People's Republic of China) Nanjing Aeronautical Institute, Journal (ISSN 1000-1956), vol. 24, Feb. 1992, p. 36-45. In Chinese. refs

The paper describes the relation between the static pressure Ps, at entrance and the total dynamic pressure Pt, at the outlet of an S-shaped inlet-diffuser model tested at the high incidence range 0-80 deg. The autocorrelation of the dynamic pressures at entry and outlet, the cross-correlation and maximum root-mean-square value of Pt versus incidence alpha have been discussed. The experimental results show that the maximum root-mean-square value grows first with increasing alpha, then goes down when alpha is higher than 60 deg. There is correlating action between Pt and Ps and the greatest action occurs at 60-deg incidence, and the swirl in the S-duct decides the positions of the largest fluctuation of Pt and the strongest correlation of Pt and Ps. Author

A92-27909
AN APPROACH TO THE LOW-SPEED LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF THE JOINED WING CONFIGURATION
JIAZHENG PAN, XIAOLIANG GUO, and QINGFENG LU (Research Institute of Pilotless Aircraft, People's Republic of China) Nanjing Aeronautical Institute, Journal (ISSN 1000-1956), vol. 24, Feb. 1992, p. 81-87. In Chinese. refs

This paper conducts an investigation into the low-speed longitudinal aerodynamic characteristics of the joined wing configuration on the basis of the test results of the longitudinal forces measured in low-speed wind tunnel and the theoretical calculation of the vortex-lattice method, compared with the test results of the corresponding conventional wing-tail configuration. It is shown that the joined wing configuration has many advantages, for example, high lift curve slope, maximum lift coefficient and longitudinal stability, high lift drag ratio K and relatively low induced drag. The paper also looks into the possibility of further increasing and improving the longitudinal aerodynamic characteristics of the joined wing configuration with the canard set in the front. Author

A92-28005
A BOUNDARY INTEGRAL FORMULATION FOR THE KINETIC FIELD IN AERODYNAMICS. II - APPLICATIONS TO UNSTEADY 2D FLOWS
P. BASSANINI (Roma I, Universita, Rome, Italy), C. M. CASCIOLA (Istituto Nazionale per Studi ed Esperienze di Architettura Navale, Rome, Italy), M. R. LANCIA (CNR, Istituto per le Applicazioni del Calcolo, Rome, Italy), and R. PIVA (Roma I, Universita, Rome, Italy) European Journal of Mechanics, B/Fluids (ISSN 0997-7546), vol. 11, no. 1, 1992, p. 69-92. Research supported by MURST. refs
(Contract CNR-91,01319,01; CNR-90,01532,01)
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The boundary-integral formulation for the velocity field in aerodynamics is investigated in detail in the 2D case. The formulation is purely kinematical and includes rotational flows and potential flows with or without circulation. A scalar boundary-integral equation (derived from the appropriate version of the Poincare identity for exterior domains) is analyzed and a stability estimate for the (weak) solution is proved. A model for the generation of vorticity for unsteady flows past airfoils is derived from the Euler equations and its relation with the Kutta condition for steady flows is discussed. Numerical results are obtained using collocation and Galerkin techniques for unsteady 2D flows of interest in aerodynamics. Flows past airfoils starting from rest where the circulation and vorticity are determined from the wake model and steady flows with circulation are determined from the Kutta condition. The present approach compares favorably with classical formulations in terms of the velocity potential in the irrotational case. Author

A92-28006
A STUDY OF THE INTERACTION OF A NORMAL SHOCK WAVE WITH A TURBULENT BOUNDARY LAYER AT MACH NUMBERS BETWEEN 1.30 AND 1.55
C. J. ATKIN and C. SQUIRE (Cambridge, University, England) European Journal of Mechanics, B/Fluids (ISSN 0997-7546), vol. 11, no. 1, 1992, p. 93-118. Research supported by SERC. refs
Copyright

This paper presents the results of an experimental and numerical investigation of the steady interaction of a normal shock wave with a turbulent boundary layer. The main feature of the experimental work is the use of techniques developed to study the unsteady interaction to obtain very accurate surface-pressure distributions for the steady interaction. Results are obtained at close intervals in Mach numbers between 1.30 and 1.55. Holographic interferometric photographs and spark shadowgraph photographs of the flow are presented at all the test Mach numbers. Density contours from these numerical solutions are compared with the interference fringes, and the best turbulence models are then used to examine physical features of the interaction. The combined experimental and numerical results are used to develop a complete description of the flow development from attached flow at $M = 1.30$ to fully separated flow at $M = 1.55$. Author

A92-28026
NUMERICAL INVESTIGATION OF LAMINAR SEPARATED TRAILING-EDGE FLOWS
F. A. MANSFIELD (U.S. Navy, Naval Weapons Center, China Lake, CA) and ODUS R. BURGGRAF (Ohio State University, Columbus) AIAA Journal (ISSN 0001-1452), vol. 30, March 1992, p. 577-583. Previously cited in issue 21, p. 3287, Accession no. A90-45883. refs

A92-28027
NUMERICAL INVESTIGATION OF VORTEX BREAKDOWN ON A DELTA WING
SHREEKANT AGRAWAL, RAYMOND M. BARNETT, and BRIAN A. ROBINSON (McDonnell Aircraft Co., Saint Louis, MO) AIAA Journal (ISSN 0001-1452), vol. 30, March 1992, p. 584-591. Research supported by McDonnell Douglas Corp. Previously announced in STAR as N92-13019. refs
Copyright
A numerical investigation of leading edge vortex breakdown in a delta wing at high angles of attack is presented. The analysis was restricted to low-speed flows on a flat plate wing with sharp leading edges. Both Euler and Navier-Stokes equations were used and the results were compared with experimental data. Predictions of vortex breakdown progression with angle of attack with both Euler and Navier-Stokes equations are shown to be consistent with the experimental data. However, the Navier-Stokes predictions show significant improvements in breakdown location at angles of attack where the vortex breakdown approaches the wing apex. The predicted trajectories of the primary vortex are in very good agreement with the test data, the laminar solutions providing the overall best comparison. The Euler shows a small displacement of the primary vortex, relative to experiment, due to the lack of secondary vortices. The turbulent Navier-Stokes, in general, fall between the Euler and laminar solutions. Author

A92-28036* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
TURBULENCE MODEL EFFECTS ON SEPARATED FLOW ABOUT A PROLATE SPHEROID
KEN GEE, RUSSELL M. CUMMINGS (California Polytechnic State University, San Luis Obispo), and LEWIS B. SCHIFF (NASA, Ames Research Center, Moffett Field, CA) AIAA Journal (ISSN 0001-1452), vol. 30, March 1992, p. 655-664. Previously cited in issue 21, p. 3285, Accession no. A90-45855. refs
(Contract NCC2-564)
Copyright

A92-28039
CARTESIAN EULER METHOD FOR ARBITRARY AIRCRAFT CONFIGURATIONS
BORIS EPSTEIN, ALEXANDER L. LUNTZ, and AHARON NACHSHON (Israel Aircraft Industries, Ltd., Lod) AIAA Journal (ISSN 0001-1452), vol. 30, March 1992, p. 679-687. Previously cited in issue 18, p. 2750, Accession no. A89-41806. refs
Copyright

A92-28041* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
EFFECT OF AIRFOIL (TRAILING-EDGE) THICKNESS ON THE NUMERICAL SOLUTION OF PANEL METHODS BASED ON THE DIRICHLET BOUNDARY CONDITION
STEVEN YON, JOSEPH KATZ, and ALLEN PLOTKIN (San Diego State University, CA) AIAA Journal (ISSN 0001-1452), vol. 30, March 1992, p. 697-702. refs
(Contract NCC2-596)
The practical limit of airfoil thickness ratio for which acceptable engineering results are obtainable with the Dirichlet boundary-condition-based numerical methods is investigated. This is done by studying the effect of thickness on the calculated pressure distribution near the trailing edge and by comparing the aerodynamic coefficients with available exact solutions. The first objective of this study, owing to the wide use of such computational methods, is to demonstrate the numerical symptoms that occur when the body or wing thickness approaches zero and to increase the awareness of potential users of these methods. Additionally, an effort is made to obtain the practical limits of the trailing-edge thickness where such problems will appear in the flow solution, and to propose some possible cures for very thin airfoils or those with cusped trailing edges. Author

A92-28042
OSCILLATING TWO-DIMENSIONAL HYPERSONIC AIRFOILS AT SMALL ANGLES OF ATTACK
HAMDI T. HEMDAN (King Saud University, Riyadh, Saudi Arabia) AIAA Journal (ISSN 0001-1452), vol. 30, March 1992, p. 703-710. refs
Copyright
Pitching oscillations of two-dimensional pointed-nose thin airfoils with small surface curvature are considered in this paper. The analysis relies on recently developed theories for steady and unsteady hypersonic flows past such airfoils. For small surface curvature tau and small reduced frequency k, a double series in tau and k is assumed here and shown to lead to very simple systems of linear equations having first- or second-degree polynomial solutions. Thus, simple closed-form formulas for the unsteady surface pressure and the stability derivatives of any curved nonsymmetric airfoil (with different upper and lower surface shapes), pitching at a small angle of attack, are obtained. Results for symmetric wedges at zero incidence are compared with other available analytical and experimental calculations and the agreement is found to be generally good. Author

A92-28043* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
TRANSIENT BEHAVIOR OF SUPERSONIC FLOW THROUGH INLETS
H. S. PORDAL, P. K. KHOSLA, and S. G. RUBIN (Cincinnati, University, OH) AIAA Journal (ISSN 0001-1452), vol. 30, March 1992, p. 711-717. Previously cited in issue 19, p. 2976, Accession no. A90-42734. refs
(Contract NAG3-1178; AF-AFOSR-90-0096)
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A92-28044* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
AERODYNAMIC DESIGN OPTIMIZATION USING SENSITIVITY ANALYSIS AND COMPUTATIONAL FLUID DYNAMICS
OKTAY BAYSAL and MOHAMED E. ELESHAKY (Old Dominion University, Norfolk, VA) AIAA Journal (ISSN 0001-1452), vol. 30, March 1992, p. 718-725. Previously cited in issue 07, p. 973, Accession no. A91-21505. refs
(Contract NAG1-1188)
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A92-28047
EXPERIMENTAL INVESTIGATION OF THE PERPENDICULAR ROTOR BLADE-VORTEX INTERACTION AT TRANSONIC SPEEDS
IRAJ M. KALKHORAN (Polytechnic University, Farmingdale, NY), DONALD R. WILSON, and DONALD D. SEATH (Texas, University, Arlington) AIAA Journal (ISSN 0001-1452), vol. 30, March 1992, p. 747-755. Previously cited in issue 08, p. 1035, Accession no. A87-22486. refs
(Contract DAAG29-84-K-131)
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A92-28062* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
NUMERICAL SIMULATION OF VORTEX UNSTEADINESS ON A SLENDER BODY AT HIGH INCIDENCE
DAVID DEGANI (NASA, Ames Research Center, Moffett Field, CA) AIAA Journal (ISSN 0001-1452), vol. 30, March 1992, p. 841-843. refs
Copyright
Numerical results obtained with the present3D thin-layer Navier-Stokes solver are shown to qualitatively follow experimental results. They also indicate the existence of at least two main frequencies on an ogive cylinder at 40 and 60 deg angles-of-attack: (1) a low frequency associated with fluctuations of the primary vortices, and leads to vortex shedding, and (2) a high frequency associated with shear-layer fluctuations that are concentrated in several small areas above the leeward side of the body's cylindrical portion. O.C.

A92-28186*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
UNSTEADY AERODYNAMIC INTERACTION EFFECTS ON TURBOMACHINERY BLADE LIFE AND PERFORMANCE
JOHN J. ADAMCZYK (NASA, Lewis Research Center, Cleveland, OH) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 21 p. refs
(AIAA PAPER 92-0149) Copyright

This paper is an attempt to address the impact of a class of unsteady flows on the life and performance of turbomachinery blading. These class of flows to be investigated are those whose characteristic frequency is an integral multiple of rotor shaft speed. Analysis of data recorded downstream of a compressor and turbine rotor will reveal that this class of flows can be highly three-dimensional and may lead to the generation of secondary flows within downstream blading. By explicitly accounting for these unsteady flows in the design of turbomachinery blading for multistage applications, it may be possible to bring about gains in performance and blade life. Author

A92-28192*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
HELIUM BUBBLE FLOW VISUALIZATION OF THE SPANWISE SEPARATION ON A NACA 0012 WITH SIMULATED GLAZE ICE
M. KERHO, M. BRAGG (Illinois, University, Urbana), and J. SHIN (NASA, Lewis Research Center, Cleveland, OH) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 16 p. refs
(Contract NAG3-1134)
(AIAA PAPER 92-0413) Copyright

Research has been performed to experimentally visualize and document the flow separation due to simulated glaze ice accretion on a NACA 0012 semispan with 30-deg sweep using helium bubbles as flow tracers. Results are compared to Navier-Stokes computational simulations for different angles of attack. Prior to acquiring data for the semispan model, a two-dimensional experiment was conducted to determine the accuracy of using the helium bubbles as flow tracers. Results from the 3D experiment compare well to the computational simulations. Author

A92-28193*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
NUMERICAL EXPERIMENTS ON A NEW CLASS OF NONOSCILLATORY SCHEMES
AMBADY SURESH (NASA, Lewis Research Center; Sverdrup Technology, Inc., Cleveland, OH) and HUNG T. HUYNH (NASA, Lewis Research Center, Cleveland, OH) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 10 p. refs
(Contract NAS3-25266)
(AIAA PAPER 92-0421) Copyright

Numerical experiments for the SONIC schemes on 2D inviscid, compressible, steady, and unsteady problems are presented. These schemes belong to a new class of uniformly second-order accurate nonoscillatory schemes introduced by Huynh, with the well known UNO2 scheme of Harten and Osher being the most 'diffusive' in this class. The SONIC schemes can also be considered as uniformly second order accurate extensions of the popular TVD schemes. For simplicity, a MUSCL approach for spatial discretization and a Runge-Kutta method for time integration are used. Test problems include steady oblique shock reflection and the well known unsteady double Mach reflection problem. Results confirm that the SONIC schemes are more accurate than their TVD counterparts. Author

A92-28194*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
AEROELASTIC ANALYSIS OF ADVANCED PROPELLERS USING AN EFFICIENT EULER SOLVER
R. SRIVASTAVA (NASA, Lewis Research Center, Cleveland; Toledo, University, OH), T. S. R. REDDY (Toledo, University, OH), and O. MEHMED (NASA, Lewis Research Center, Cleveland, OH) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 14 p. refs
(Contract NAG3-730)
(AIAA PAPER 92-0488)

A 3D Euler solver is coupled with a 3D structural dynamics model to investigate flutter of propfans. A hybrid scheme is used to reduce computational time for the Euler equations and a normal mode analysis is used for flutter calculations. Experimental and calculated flutter results are compared for an advanced propeller propfan which experienced flutter at transonic tip relative velocities. The predicted flutter calculations are in close agreement with the experimental data. A structural damping value of 0.5 percent was required to predict the behavior observed in the experiment. Computations show that the flutter behavior is dominated by the second mode, but coupling with the first mode is required. The addition of other modes to the calculations did not affect the flutter behavior. Author

A92-28196#
LDV MEASUREMENTS OF THE VELOCITY FIELD IN AN UNDEREXPANDED SUPERSONIC JET (MA = 1.5)
ROBERT E. DEOTTE, JR., GERALD L. MORRISON, and ROBERT D. SEWELL (Texas A & M University, College Station) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 13 p. Research supported by General Dynamics Corp. refs
(AIAA PAPER 92-0504) Copyright

A laser Doppler velocimeter (LDV) was used to make measurements of the flow field in a cold, choked, underexpanded jet issuing from an axisymmetric convergent nozzle at a pressure ratio of 3.75:1. The LDV was configured in a forward scatter arrangement to improve the signal to noise ratio adequately to obtain reliable measurements. With this configuration radial traverses were made of the jet at numerous axial locations to provide both the axial and radial components of velocity and the axial turbulence intensity. The flow field possesses a Mach disk in the first shock cell followed by numerous other shock cells until the flow becomes subsonic. Author

A92-28197*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ESTIMATION OF PROPULSION-INDUCED EFFECTS ON TRANSONIC FLOWS OVER A HYPERSONIC CONFIGURATION
PETER M. HARTWICH (Vigyan, Inc., Hampton, VA) and NEAL T. FRINK (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 13 p. refs
(Contract NAS1-18585)
(AIAA PAPER 92-0523)

Boundary conditions are formulated for treating selected patches of a subject configuration as inlet or nozzle areas. For subsonic inflow, the mass flow through the inlet is controlled by the exhaust conditions and the effects of mass and heat addition. For supersonic inflow, the exhaust conditions are based on the inlet conditions and on combustion data. These formulations were included into an existing Euler/Navier-Stokes solver. Comparisons with experimental data demonstrate that the resulting software package efficiently permits the assessment of propulsion-induced effects on external flow fields, particularly around highly blended configurations. C.D.

A92-28199*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
THREE-DIMENSIONAL STRUCTURE OF A CURVED WAKE
J. H. WEYGANDT and R. D. MEHTA (NASA, Ames Research Center, Moffett Field; Stanford University, CA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 16 p. refs
(Contract NCC2-55)
(AIAA PAPER 92-0541) Copyright

The effects of streamwise curvature on the 3D structure of a plane wake are studied. Preliminary results indicate that the wake is initially grossly 3D with large spanwise distortions in the mean

velocity and Reynolds stress contours. Local extrema distributed in a quasi-periodic manner are seen. The spanwise variations are caused by the presence of relatively strong quadrupoles of mean streamwise vorticity. Further downstream the mean vorticity decays at a rate lower on the unstable side of the wake so that only the unstable side row of vortices persist to the far-field region. As a result, the spanwise distortions and local extrema seem to persist with a relatively slow decay. The effects of curvature are also apparent in the Reynolds stress results. In particular, the shear stress is significantly affected by curvature right from the start such that significantly higher magnitudes are observed on the unstable side. The curved wake clearly develops a very 3D asymmetric structure which shows no signs of reaching an equilibrium state. C.D.

A92-28200*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

UNSTEADY AIRFOIL FLOW SOLUTIONS ON MOVING ZONAL GRIDS

ANTONIO S. CRICELLI (U.S. Naval Postgraduate School, Monterey, CA), JOHN A. EKATERINARIS (NASA, Ames Research Center; U.S. Navy-NASA Joint Institute of Aeronautics, Moffett Field, CA), and MAX F. PLATZER (U.S. Naval Postgraduate School, Monterey, CA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 13 p. Research supported by U.S. Naval Postgraduate School. refs

(AIAA PAPER 92-0543)

Euler and Navier-Stokes solutions for airfoil flows on zonal grids are presented. The governing equations are solved with an implicit, iterative, factorized numerical scheme. The inviscid fluxes are examined with a third-order accurate upwind method. Zonal grid solutions are compared with experimental measurements for flows over airfoils at fixed angles of incidence. The computed unsteady solutions for rapidly pitching and oscillating airfoils are in good agreement with experiments. R.E.P.

A92-28202*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

EFFECTIVE TREATMENTS OF THE SINGULAR LINE BOUNDARY PROBLEM FOR THREE DIMENSIONAL GRIDS

GRANT PALMER (NASA, Ames Research Center, Moffett Field, CA) and ETHIRAJ VENKATAPATHY (Eloret Institute, Palo Alto, CA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 20 p. refs

(Contract NCC2-420)

(AIAA PAPER 92-0545) Copyright

The axis singularity problem for 3D blunt body flows is examined. Two techniques of eliminating the axis-singularity difficulty are presented for utilization with finite-difference codes: (1) the 3D Navier-Stokes equations are reformulated utilizing a redefined Jacobian that is nonzero at the singular line, and (2) the 3D Navier-Stokes equations are solved using the Roe flux-difference splitting technique with a finite-volume based method for evaluation of the grid Jacobian and the metrics, and appropriate boundary conditions. Real-gas and viscous computations are also presented, demonstrating the generality of the two methods. R.E.P.

A92-28204*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

THE STRUCTURE AND DEVELOPMENT OF STREAMWISE VORTEX ARRAYS EMBEDDED IN A TURBULENT BOUNDARY LAYER

BRUCE J. WENDT, ISAAC GREBER (Case Western Reserve University, Cleveland, OH), and WARREN R. HINGST (NASA, Lewis Research Center, Cleveland, OH) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 21 p. refs

(Contract NAG3-520)

(AIAA PAPER 92-0551) Copyright

The results of an experimental investigation of the structure and development of streamwise vortices embedded in a turbulent boundary layer are presented. Measurements of secondary velocity in the crossplane are used to characterize the vortex array structure. Measurements in the crossplane at two streamwise locations characterize the influence of interactions among the vortices on the array structure when the initial spacing between vortices is varied. Evidence of the merging of counter-rotating cores is found in embedded arrays of closely spaced vortices. A model of vortex interaction and development is constructed from the experimental results. This model is based on the structure of the two dimensional Ossen vortex. The decay of vortex circulation due to the merging of the cores is correlated with the crossplane gradient in streamwise vorticity occurring between an embedded vortex and its adjacent counter-rotating neighbors. Author

A92-28213*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

A NUMERICAL STUDY OF THE EFFECTS OF GEOMETRY ON THE PERFORMANCE OF A SUPERSONIC COMBUSTOR

DEAN R. EKLUND (U.S. National Research Council, Hampton, VA) and G. B. NORTHAM (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 18 p. Research supported by U.S. National Research Council. refs

(AIAA PAPER 92-0624)

A numerical study is conducted to investigate the effects of two combustor scale parameters, the expansion angle and the length of the constant area combustor section, on the mixing and combustion within a supersonic combustor. This study uses the SPARK 3D Navier-Stokes code. Turbulence is modeled utilizing an algebraic eddy viscosity model and the chemical mechanism is modeled with a 7-reaction, 7-species finite-rate chemistry model. The calculations show that, even at the relatively low flight Mach numbers (5-7) associated with the conditions examined, the chemical constituents are far from equilibrium, and therefore that kinetics effects are important. R.E.P.

A92-28215*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

COMPARISON OF TWO-DIMENSIONAL AND THREE-DIMENSIONAL DROPLET TRAJECTORY CALCULATIONS IN THE VICINITY OF FINITE WINGS

STANLEY R. MOHLER, JR. (NASA, Lewis Research Center, Cleveland; Sverdrup Technology, Inc., Brook Park, OH) and COLIN S. BIDWELL (NASA, Lewis Research Center, Cleveland, OH) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 33 p. refs

(AIAA PAPER 92-0645) Copyright

Computational predictions of ice accretion on flying aircraft most commonly rely on modeling in 2D. These 2D methods treat an aircraft geometry either as wing-like with infinite span, or as an axisymmetric body. Recently, fully 3D methods have been introduced that model an aircraft's true 3D shape. Because 3D methods are more computationally expensive than 2D methods, 2D methods continue to be widely used. However, a 3D method allows investigation of whether it is valid to continue applying 2D methods to a finite wing. The extent of disagreement between LEWICE, a 2D method, and LEWICE3D, a 3D method, in calculating local collection efficiencies at the leading edge of finite wings is investigated. Author

A92-28217*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

FLOWFIELD SIMULATION ABOUT THE SOFIA AIRBORNE OBSERVATORY

CHRISTOPHER A. ATWOOD and WILLIAM R. VAN DALSEM (NASA, Ames Research Center, Moffett Field, CA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 14 p. refs

(AIAA PAPER 92-0656) Copyright

The Reynolds averaged Navier-Stokes equations have been applied to Stratospheric Observatory For Infrared Astronomy (SOFIA) configurations. Comparisons between numerical and experimental results are made in two-dimensions for free shear layers and a rectangular cavity, and in three-dimensions for simplified SOFIA geometries. Dominant acoustic behaviour of the cavity flows compare well with experiment. The sensitivity of the

solutions to changes in grid cell size and artificial dissipation levels are shown. Furthermore, optical path distortion due to the flow field is modelled using geometrical constructs. The results demonstrate the viability and usefulness of the present computational methods for this class unsteady applications.
Author

A92-28218# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
LEADING EDGE SWEEP EFFECTS IN GENERIC THREE-DIMENSIONAL SIDEWALL COMPRESSION SCRAMJET INLETS
AARON B. COZART (North Carolina State University, Raleigh), SCOTT D. HOLLAND, CARL A. TREXLER (NASA, Langley Research Center, Hampton, VA), and JOHN N. PERKINS (North Carolina State University, Raleigh) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 11 p. refs
(Contract NGT-70161)
(AIAA PAPER 92-0674) Copyright

A computational and experimental study of generic 3D sidewall compression inlets is conducted to examine the effects of fore and aft leading edge sweep on the internal shock structure. Inlets with leading edge sweeps of +30 deg and -30 deg with sidewall compression angles of 6 deg were tested in the NASA Langley Mach 4 air tunnel at a geometric contraction ratio of 1.87. The principal difference in performance was determined to be in the mass capture. Spillage was identified as having two components: a pressure induced component and a sweep induced component. It was found that while the direction of the leading edge sweep had a large influence on the spillage, the pressure effects were more important.
R.E.P.

A92-28223*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DIRECT NUMERICAL SIMULATION OF LAMINAR BREAKDOWN IN HIGH-SPEED, AXISYMMETRIC BOUNDARY LAYERS
C. D. PRUETT (Analytical Services and Materials, Inc., Hampton, VA) and T. A. ZANG (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 12 p. refs
(AIAA PAPER 92-0742)

Temporal direct numerical simulation of laminar breakdown via subharmonic secondary instability in high-speed axisymmetric boundary layers has been accomplished using a highly accurate, fully explicit algorithm which combines spectral collocation and high-order compact-difference techniques. Numerical test cases confirm that subharmonic secondary instability is confirmed to be a viable path to transition in high-speed boundary-layer flow. Secondary instability is shown to account for peaks in the Reynolds stresses at or near the critical layer which are not possible from the second-mode primary instability alone. Reynolds stresses spatially reconstructed from the temporal model via the Gaster transformation show a 'spreading angle' of about 12 deg, in qualitative agreement with experimental findings. The rate of broadening of the Reynolds stress peak is a strongly nonlinear phenomenon which cannot be reproduced by secondary instability theory.
C.D.

A92-28224*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SECONDARY INSTABILITY MECHANISMS IN COMPRESSIBLE, AXISYMMETRIC BOUNDARY LAYERS
LIAN L. NG (Analytical Services and Materials, Inc., Hampton, VA) and THOMAS A. ZANG (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 11 p. refs
(Contract NAS1-18599)
(AIAA PAPER 92-0743)

Secondary instability mechanisms in compressible, axisymmetric boundary layers are analyzed using spectrally-accurate mean-flow and stability codes. Results show that subharmonic disturbances are the most dangerous secondary disturbances in an environment with a low to moderate intensity of the primary disturbance. The relation between spatial and temporal analyses of the secondary disturbance is explored at Mach 1.6 along a flat plate and Mach 6.8 along a cone. Spatial direct numerical simulations are utilized to confirm the quantitative predictions from spatial secondary instability theory.
Author

A92-28476
AN INVESTIGATION OF THE SWIRL IN AN S-SHAPED INLET
GUOCAI YANG and SUI ZHENG (Chengdu Aircraft Industrial Co., People's Republic of China) Journal of Propulsion Technology (ISSN 1001-4055), Feb. 1992, p. 1-7. In Chinese. refs

Based on theoretical considerations and, primarily, on experimental result, it is shown that the performance of a normal supersonic S-shaped belly inlet is sensitive to sideslip and that bulk swirl may occur. Depending on the sensitivity of the engine to swirl disturbances in the absence of inlet guide vanes, the engine performance may deteriorate and serious problem in engine/inlet compatibility, such as engine surge and fan vibration, may occur. The use of dynamic total pressure distortion as primary compatibility parameter is questionable, and it is indicated that, for the engine with larger stall margin, swirl should be the key parameter in engine/inlet compatibility. A new way is developed to determine quickly if there is any bulk swirl at inlet exit without measuring swirl.
Author

A92-28477
AN EXPERIMENTAL INVESTIGATION OF THE INLET EXIT FLOW FIELD IMPROVED BY AERODYNAMIC GRID
SI LIANG, CHANMIN ZHANG, and LONG ZHANG (31st Research Institute, People's Republic of China) Journal of Propulsion Technology (ISSN 1001-4055), Feb. 1992, p. 8-13, 74. In Chinese. refs

A new type device, aerodynamic grid, is introduced to make uniform the flow field at the duct exit. Experimental investigation of both the aerodynamic grid and the wire screen mounted at the downstream of ramjet inlet has been conducted, and comparison of the experimental results has been made. The results of investigation show that the effect of aerodynamic grid on the flow field is better than that of wire screen under inlet supercritical condition. At the freestream Ma = 1.8 and zero angle of attack of the inlet, the total pressure distortion of flow at aerodynamic grid exit can be reduced by 50 percent as compared with that of flow at wire screen exit.
Author

A92-28478
DESIGN AND CALCULATION OF PERFORMANCE OF A SUBSONIC INLET DUCT
DEWANG LIANG and XIAO CHEN (Nanjing Aeronautical Institute, People's Republic of China) Journal of Propulsion Technology (ISSN 1001-4055), Feb. 1992, p. 14-18, 74. In Chinese. refs

A concept of optimum design concerning a subsonic inlet duct is proposed on the experimental investigations of subsonic diffusers in past years. The function of the program about the design and calculation of performance of the subsonic inlet duct is described. The experimental results obtained in practice show that the program can be used in the earlier stage of the design of the inlet to replace or reduce the experiments for model selecting, so the experimental expenses and time for design can be greatly reduced.
Author

A92-28501
FULL NAVIER-STOKES ANALYSIS OF A THREE-DIMENSIONAL HYPERSONIC MIXED COMPRESSION INLET
JEFFERY A. WHITE (Pratt and Whitney Group, West Palm Beach, FL) and CHAE M. RHIE (Pratt and Whitney Group, East Hartford, CT) Journal of Propulsion and Power (ISSN 0748-4658), vol. 8, Mar.-Apr. 1992, p. 257, 258. Abridged. Previously cited in issue 23, p. 3758, Accession no. A88-53138. refs
Copyright

A92-28519
CALCULATION OF THREE-DIMENSIONAL TRANSONIC TURBINE CASCADE FLOW
H. ZIMMERMANN (DLR, Institut fuer Theoretische Stroemungsmechanik, Goettingen, Federal Republic of Germany) Journal of Propulsion and Power (ISSN 0748-4658), vol. 8, Mar.-Apr. 1992, p. 382-391. Previously cited in issue 16, p. 2483, Accession no. A90-38686. refs
Copyright

A92-28522
INVISCID AND VISCOUS TRANSONIC FLOWS IN CASCADES USING AN IMPLICIT UPWIND ALGORITHM
HANNES BENETSCHIK and HEINZ E. GALLUS (Aachen, Rheinisch-Westfaelische Technische Hochschule, Federal Republic of Germany) Journal of Propulsion and Power (ISSN 0748-4658), vol. 8, Mar.-Apr. 1992, p. 403-409. Previously cited in issue 18, p. 2815, Accession no. A90-42034. refs
Copyright

A92-28523* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
NAVIER-STOKES SOLUTION OF TRANSONIC CASCADE FLOWS USING NONPERIODIC C-TYPE GRIDS
ANDREA ARNONE (Firenze, Universita, Florence, Italy), MENG-SING LIOU, and LOUIS A. POVINELLI (NASA, Lewis Research Center, Cleveland, OH) Journal of Propulsion and Power (ISSN 0748-4658), vol. 8, Mar.-Apr. 1992, p. 410-417. Previously announced in STAR as N91-11192. refs
Copyright

A new kind of C-type grid is proposed, this grid is non-periodic on the wake and allows minimum skewness for cascades with high turning and large camber. Reynolds-averaged Navier-Stokes equations are solved on this type of grid using a finite volume discretization and a full multigrid method which uses Runge-Kutta stepping as the driving scheme. The Baldwin-Lomax eddy-viscosity model is used for turbulence closure. A detailed numerical study is proposed for a highly loaded transonic blade. A grid independence analysis is presented in terms of pressure distribution, exit flow angles, and loss coefficient. Comparison with experiments clearly demonstrates the capability of the proposed procedure. Author

A92-28524
INVESTIGATION OF OBLIQUE SHOCK/BOUNDARY-LAYER BLEED INTERACTION
A. HAMED and T. LEHNIG (Cincinnati, University, OH) Journal of Propulsion and Power (ISSN 0748-4658), vol. 8, Mar.-Apr. 1992, p. 418-424. Previously cited in issue 19, p. 2976, Accession no. A90-42697. refs
(Contract F49620-88-C-0053)
Copyright

A92-28526* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
THREE-DIMENSIONAL VISCOUS ANALYSIS OF A MACH 5 INLET AND COMPARISON WITH EXPERIMENTAL DATA
D. R. REDDY (NASA, Lewis Research Center, Cleveland; Sverdrup Technology, Inc., Brook Park, OH) and L. J. WEIR (NASA, Lewis Research Center, Cleveland, OH) Journal of Propulsion and Power (ISSN 0748-4658), vol. 8, Mar.-Apr. 1992, p. 432-440. Previously cited in issue 10, p. 1435, Accession no. A90-26970. refs
(Contract NAS3-25266)
Copyright

A92-28527
MULTIPLE NORMAL SHOCK WAVE/TURBULENT BOUNDARY-LAYER INTERACTIONS
BRUCE F. CARROLL (Florida, University, Gainesville) and J. C. DUTTON (Illinois, University, Urbana) Journal of Propulsion and Power (ISSN 0748-4658), vol. 8, Mar.-Apr. 1992, p. 441-448. Research supported by U.S. Navy and University of Illinois. refs
Copyright

A multiple normal shock/turbulent boundary-layer interaction in a rectangular duct has been investigated experimentally using two-component LDV. Just upstream of the normal shock system, the Mach number was 1.61, the unit Reynolds number was 30 million/m, and the confinement level as characterized by the ratio of the boundary-layer thickness to the duct half height was 0.32. The results presented here identify the fluid dynamic mechanisms involved in the reacceleration process following each shock in the multiple shock system. Two distinct expansion processes occur following each shock in the system: acceleration through a supersonic expansion fan originating near the wall and acceleration through an aerodynamic converging-diverging nozzle in the core flow. Author

N92-18007# Applied Research Lab., State College, PA.
A STUDY OF THE DIFFUSION OF SLOT-INJECTED DRAG-REDUCING POLYMER SOLUTION IN A TURBULENT BOUNDARY LAYER MODIFIED BY LARGE-EDDY BREAKUP DEVICES
STEVEN T. SOMMER and HOWARD L. PETRIE Nov. 1991 155 p
(Contract N00039-88-C-0051)
(AD-A243411; ARL/PSU/TR-92-015) Avail: NTIS HC/MF A08 CSCL 07/6

The effects of a tandem set of large-eddy breakup (LEBU) devices on the diffusion of drag-reducing polymer solution and of water injected into a turbulent boundary layer (TBL) flow have been studied. Laser-Doppler velocimeter measurements were taken in the LEBU modified TBL with and without polymer injection. A laser-induced fluorescence technique was used to examine the development of concentration profiles of the injected fluids with increasing distance from the injection slot for a range of injected rates. The diffusion rate of water, a passive contaminant, was diminished by the LEBU devices over a distance of only 10 to 15 boundary thicknesses before returning to the case of an unmodified flow. It has been found that the initial diffusion zone of the passive contaminant has been extended in the LEBU modified TBL. The LEBU devices did have a major effect on the diffusion of polymer over the entire steamwise distance studied, compared to the case of an unmodified flow. Large reductions of turbulent normal and shear stresses were observed downstream of the devices, especially with polymer injection. GRA

N92-18193 Department of the Navy, Washington, DC.
WINDOW COOLING FOR HIGH SPEED FLIGHT Patent
RICHARD T. DRIFTMYER, inventor (to Navy) 14 May 1991 4 p Filed 27 Apr. 1990 Supersedes AD-D014686
(AD-D015145; US-PATENT-5,014,932; US-PATENT-APPL-SN-517011; US-PATENT-CLASS-244-117)
Avail: US Patent and Trademark Office CSCL 20/4

A buffering portion of boundary layer flow along a flight vehicle surface is diverted into an internal cavity at a downstream edge of a surface mounted window isolating recirculating flow of the diverted fluid through the cavity while it is cooled there within. Outflow of the cooled buffering fluid from an upstream edge of the window is conducted into the buffering portion of the boundary layer flow to cool the window and prevent damage thereof by aerodynamically generated heating of the surface under high velocity flight conditions. GRA

N92-18231# Manchester Univ. (England). Aeronautical Engineering Group.
MARCHING WITH THE PARABOLIZED NAVIER-STOKES EQUATIONS. PROBLEM 1: NUMERICAL STUDY OF HYPERSONIC VISCOUS CONE FLOW
S. SHAHPAR, I. M. HALL, and D. I. A. POLL 1990 22 p
(AERO-REPT-9007; ETN-92-90924) Avail: NTIS HC/MF A03

A general noniterative, three dimensional parabolized Navier-Stokes code was developed to predict the steady viscous flow field about objects traveling at high supersonic/hypersonic speeds. The equations are solved with an implicit approximate

factorization finite difference scheme which is second order accurate in the cross flow directions. An implicit boundary condition was used which was compatible with the finite difference schemes used on the interior mesh. The grid used is generated by a simple algebraic method. Vigneron's technique was used to suppress the departure solution. The code is applied to laminar hypersonic flow, M(sub infinity) = 9.16, Re(sub infinity) = 5.5 times 10 to the 7th power/m, past a slender cone to 7 degree half angle and the computed shock shape, surface pressure, skin friction, and Stanton number are presented for comparison with experimental results.
ESA

N92-18232# Manchester Univ. (England). Aeronautical Engineering Group.
MARCHING WITH THE PARABOLIZED NAVIER-STOKES EQUATIONS. PROBLEM 2: HYPERSONIC VISCOUS FLOW OVER A FLAT PLATE
S. SHAHPAR, I. M. HALL, and D. I. A. POLL 1990 16 p
(AERO-REPT-9008; ETN-92-90925) Avail: NTIS HC/MF A03
The noniterative implicit space marching Parabolized Navier-Stokes (PNS) code described previously was used to compute the steady hypersonic (M(sub infinity) = 5 and 10), viscous (Re(sub infinity)/m = 0.000006 and Re(sub infinity)/m = 0.000003) flow fields over a flat plate aligned with the freestream. Flow maps for density, pressure, and Mach number as well as surface pressure, skin friction, and Stanton number are presented for comparison with experimental results. ESA

N92-18233# Manchester Univ. (England). Aeronautical Engineering Group.
ZONAL SOLUTIONS FOR A DOUBLE-ELLIPSE IN A HYPERSONIC FLOWFIELD
S. SHAHPAR, I. M. HALL, and D. I. A. POLL 1990 17 p
(AERO-REPT-9009; ETN-92-90926) Avail: NTIS HC/MF A03
Numerical solutions for inviscid flows past a double ellipse configuration at Mach numbers of 8.15 and 25.0 are presented. An overlapping grid system is developed and applied in the solution of hypersonic flow (M(sub infinity) = 8.15 and 25.0) over a double ellipse. The flow of information across the interfaced boundaries is achieved by linear interpolation. The two dimensional Euler equations are solved explicitly using a second order Runge-Kutta time stepping scheme. The procedure is also capable of treating three dimensional flows. ESA

N92-18239# National Aerospace Lab., Tokyo (Japan). Space Technology Research Group.
AN IMPROVED METHOD FOR SIMULATING SUPERSONIC FLOW PAST A WEDGE SHAPED BODY
KUNIO NOMIZO Feb. 1991 18 p In JAPANESE; ENGLISH summary
(NAL-TR-1097; ISSN-0389-4010) Avail: NTIS HC/MF A03
Several reports have obtained numerical solutions for supersonic flow past blunt nosed body, and in every case the method adopted can be described as an inverse marching process. This method was applied to a wedge shaped body, thus requiring an elliptical type equation to be solved. To facilitate the solution process, the pressure and density terms are eliminated from the equation so that it is composed solely of velocity terms. An initial application is discussed which constructs the solution starting from shock waves, the Taylar maccoll solution, with satisfactory results being obtained. Author

N92-18269# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Fluid Dynamics Panel.
DESIGN AND TESTING OF HIGH-PERFORMANCE PARACHUTES
R. C. MAYDEW, C. W. PETERSON, and K. J. ORLIK-RUECKEMANN (Institute for Aerospace Research, Ottawa, Ontario) Nov. 1991 302 p Original contains color illustrations
(AGARD-AG-319; ISBN-92-835-0649-9) Copyright Avail: NTIS HC/MF A14; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive
Provided here are general state-of-the-art procedures for the design and testing of high-performance parachutes. This includes the use of aerodynamic and structural analysis and application of numerical codes to predict parachute inflation, deceleration forces, payload and parachute trajectories, and canopy/suspension line stresses. Design problems such as parachute collapse, parachute line sail, parachute stability, and body-wake interaction are discussed. The use of nylon, Nomex, Kevlar, Teflon, and other materials is covered. Techniques for the design and fabrication of prototype parachutes and deployment bags are presented, and parachute packing methods are discussed. A section is included on testing of model parachutes in wind tunnels. Full-scale testing, using a sled track or aircraft drop or rocket boost to deploy the parachute at the desired Mach number and altitude, and descriptions of onboard and ground-based instrumentation are outlined. Example parachute designs are given for differing system requirements of payload weight, deployment Mach number and dynamic pressure, parachute weight/volume, etc. Author

N92-18293#. Manchester Univ. (England). Aeronautical Engineering Group.
A NUMERICAL STUDY OF THE STABILITY OF THE SWEPT ATTACHMENT LINE BOUNDARY LAYER Ph.D. Thesis
VASSILIOS THEOFILIS 1991 150 p Sponsored by Science Research Council
(AERO-REPT-9103; ETN-92-90934) Avail: NTIS HC/MF A07
The stability of the infinite swept attachment line boundary layer is studied numerically. A second order accurate finite differencing scheme is used in the normal to the wall direction, a pseudospectral approach is employed in the other directions; temporally, an explicit Crank-Nicholson scheme is used and the resulting system of equations is solved using an initial value problem approach. Extensive use of the fast Fourier transfrom algorithm was made to transform spaces. An important result is that, at a station off the attachment line, the critical Reynolds number for the onset instability is an order of magnitude smaller than the corresponding two dimensional critical Reynolds number at the attachment line. ESA

N92-18316# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Hubschrauber und Flugzeuge.
CALCULATION OF HYPERSONIC NON-EQUILIBRIUM VISCOUS FLOW USING SECOND ORDER BOUNDARY LAYER THEORY
C. MUNDT and F. MONNOYER 3 Dec. 1990 11 p Presented at the International Aerospace Congress, Melbourne, Australia, 12-16 May 1991
(MBB-FE122-S-PUB-434; ETN-92-90615) Copyright Avail: NTIS HC/MF A03
A method is presented for the calculation of hypersonic boundary layers in chemical nonequilibrium. The second order boundary layer equations are solved using a finite difference space marching method. The flow and the chemistry are solved simultaneously and the latter is modeled by up to 17 reactions for a five species mixture describing high temperature reacting air. The transport properties are modeled accordingly. ESA

N92-18318# Manchester Univ. (England). Aeronautical Engineering Group.
TOWARDS THE COMPUTATION OF TURBULENT HYPERSONIC FLOWS
B. E. LAUNDER (Manchester Coll. of Science and Technology, England) and D. I. A. POLL Aug. 1991 110 p
(AERO-REPT-9106; ETN-92-90937) Avail: NTIS HC/MF A06
The status of engineering turbulence modeling in relation to the problem of predicting hypersonic turbulent flows is considered. To provide a perspective for making such an assessment, the experimental data base and the associated experimental uncertainties are reviewed. Various levels of turbulence model are considered proceeding from the simplest (algebraic eddy viscosity models) to the most elaborate (multiple scale models based on transport equations for the turbulent stresses). No attempt is made to cover the problem of transition from laminar to turbulent flow

in a quiescent free stream. Since, however, incompletely turbulent boundary layers are the general rule at hypersonic speed, particular attention is given to the capabilities of different levels of turbulence model in predicting flows with abnormally thick viscous sublayers.
ESA

N92-18345# EMA, Mansfield, TX.
ROTORWASH COMPUTER MODEL: USER'S GUIDE Final Report, Dec. 1989 - Jun. 1990
SAMUEL W. FERGUSON and J. DAVID KOCUREK Nov. 1991 156 p Prepared in cooperation with Computational Methodology Associates, Hurst, TX
(Contract DTRS57-87-P-81048)
(DOT/FAA/RD-90/25; EMA-TR-87-5-1) Avail: NTIS HC/MF A08
The user's guide for the Rotorwash (ROTWASH) Analysis program is documented. This computer program is used to analyze the rotorwash flow field characteristics and their effect on the environment for rotorcraft in hovering and low speed flight in close proximity to the ground. Step by step descriptions are provided on the use of each analysis option along with a listing of the IMB PC/PC compatible based FORTRAN 77 software. The history is briefly described of the ROTWASH analysis software. References to the mathematical models used are included. Author

N92-18484# National Aerospace Lab., Tokyo (Japan). Advanced Aircraft Research Group.
AN APPROACH TO FLOW FIELD MEASUREMENT BY LASER 2-FOCUS VELOCIMETER (L2F) IN GUST WIND TUNNEL [TOPPU FUDOYO REZA 2 SHOTEN RYUSOKUKEI O MOCHIITA NAGAREBA KEISOKU NO KOKOROMI]
KENICHI RINOIE, TOSHIMI FUJITA, AKIHITO IWASAKI, and HIROTOSHI FUJIEDA Mar. 1990 25 p In JAPANESE
(NAL-TM-617; ISSN-0452-2982; JTN-92-80289) Avail: NTIS HC/MF A03
This report introduces the laser dual focus velocimeter of National Aerospace Laboratory (NAL) gust wind tunnel. The background, measurement theory, instruments configuration, data processing flow, and measurement error of this velocimeter are presented in the report. To present the accuracy and problems in using this velocimeter, some measurement results, such as the wind tunnel flow and stream line, are shown in this report.
Author (NASDA)

N92-18760*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
SEMI-EMPIRICAL MODEL FOR PREDICTION OF UNSTEADY FORCES ON AN AIRFOIL WITH APPLICATION TO FLUTTER
APARAJIT J. MAHAJAN (Toledo Univ., OH.) and KRISHNA RAO V. KAZA Feb. 1992 28 p
(NASA-TM-105414; E-6820; NAS 1.15:105414) Avail: NTIS HC/MF A03 CSCL 01/1
A semi-empirical model is described for predicting unsteady aerodynamic forces on arbitrary airfoils under mildly stalled and unstalled conditions. Aerodynamic forces are modeled using second order ordinary differential equations for lift and moment with airfoil motion as the input. This model is simultaneously integrated with structural dynamics equations to determine flutter characteristics for a two degrees-of-freedom system. Results for a number of cases are presented to demonstrate the suitability of this model to predict flutter. Comparison is made to the flutter characteristics determined by a Navier-Stokes solver and also the classical incompressible potential flow theory. Author

N92-18783# Wright Lab., Wright-Patterson AFB, OH.
NON-LINEAR AIRLOADS HYPERSURFACE REPRESENTATION: A TIME DOMAIN PERSPECTIVE
J. E. JENKINS and E. S. HANFF (National Aeronautical Establishment, Ottawa, Ontario) *In* AGARD, Manoeuvring Aerodynamics 9 p Nov. 1991 Sponsored in part by AFOSR and Dept. of National Defence
Copyright Avail: NTIS HC/MF A13; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive
Representation of nonlinear and unsteady airloads by the reaction hypersurface model is shown to be a special case of the nonlinear indicial response model. The principal requirement is that the motions are analytical (in the strict mathematical sense) to ensure uniqueness. Static and roll oscillation test data for a 65 deg delta wing at an angle of attack of 30 deg were analyzed using the theoretical relationships between the two models. Analysis results indicate that the existence of singularities in the static rolling moment variation with roll angle invalidate the current model. Additional experiments are planned to resolve this issue.
Author

N92-18825# Micro Craft, Inc., Tullahoma, TN.
COMPUTATION OF A KELVIN-HELMHOLTZ INSTABILITY FOR DELTA WING VORTEX FLOWS Final Report, 1 Sep. 1990 - 1 Sep. 1991
RAYMOND E. GORDNIER Nov. 1991 39 p
(Contract F33601-89-D-0045)
(AD-A244320; WL-TR-91-3098) Avail: NTIS HC/MF A03 CSCL 01/1
The structure of the shear layer which emanates from the leading edge of a 76 degrees sweep delta wing and forms the primary vortex is investigated numerically. The flow conditions are M at infinity = 0.2, Re = 50,000, and angle of attack of 20.5 degrees. Computational results are obtained using a Beam-Warning type algorithm. The existence of a Kelvin-Helmholtz type instability of the shear layer which emanates from the leading edge of the delta wing is demonstrated. A description is provided of the three-dimensional, unsteady behavior of the small-scale vortices associated with this instability. The numerical results are compared qualitatively with experimental flow visualizations exhibiting similar behavior. GRA

N92-18895# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
AN EXPERIMENTAL STUDY OF A STING-MOUNTED CIRCULATION CONTROL WING M.S. Thesis
STEVEN J. LACHER Dec. 1991 136 p
(AD-A243912; AFIT/GAE/ENY/91D-4) Avail: NTIS HC/MF A07 CSCL 01/1
This wind tunnel study investigated the lift, drag, and pitching moment of a 20 percent thick, 8.5 percent camber, partial elliptical cross-section, single blowing slot, 2.325 aspect ratio, rectangular circulation control wing. The AFIT 5-foot wind tunnel was used. Lift and drag were referenced to the wind axis. The Reynolds number was 500,000 for all tests. Angle of attack was varied from -6 to 16 degrees and the effects of pulsed blowing were investigated. Effects of tripping the Coanda jet with a small flow barrier attached spanwise along the Coanda surface were also studied. Results indicate that there is a limit on maximum lift obtainable by increasing circulation. The limit is presumed to be the result of three-dimensional effects. Pulsed blowing has little effect on average lift, but results in violent oscillation of the wing as the sting physically bends under cyclic loading. In certain situations, tripping the Coanda jet may reduce drag without decreasing lift. GRA

N92-19002*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
INSTALLATION EFFECTS OF WING-MOUNTED TURBOFAN NACELLE-PYLONS ON A 1/17-SCALE, TWIN-ENGINE, LOW-WING TRANSPORT MODEL
ODIS C. PENDERGRAFT, JR., ANTHONY M. INGRALDI, RICHARD J. RE, and TIMMY T. KARIYA (Vigyan Research Associates, Inc., Hampton, VA.) Mar. 1992 108 p
(NASA-TP-3168; L-16960; NAS 1.60:3168) Avail: NTIS HC/MF A06 CSCL 01/1
A twin-engine, low-wing transport model, with a supercritical wing of aspect ratio 10.8 designed for a cruise Mach number of 0.77 and a lift coefficient of 0.55, was tested in the Langley 16-Foot Transonic Tunnel. The purpose of this test was to compare the wing-nacelle interference effects of flow-through nacelles simulating superfan engines (very high bypass ratio (BPR is approx. = 18) turbofan engines) with the wing-nacelle interference effects of

current-technology turbofans (BPR is approx. = 6). Forces and moments on the complete model were measured with a strain-gage balance, and extensive external static-pressure measurements (383 orifice locations) were made on the wing, nacelles, and pylons of the model. Data were taken at Mach numbers from 0.50 to 0.80 and at model angles of attack from -4 deg to 8 deg. Test results indicate that flow-through nacelles with a very high bypass ratio can be installed on a low-wing transport model with a lower installation drag penalty than for a conventional turbofan nacelle at a design cruise Mach number of 0.77 and lift coefficient of 0.55. Author

N92-19085# Naval Surface Warfare Center, Silver Spring, MD.
NOTES ON THE CAUSE OF PARACHUTE CRITICAL VELOCITY Report, FY 1990 - FY 1991
WILLIAM P. LUDTKE 25 Jun. 1991 62 p
(AD-A244417; NAVSWC-TR-91-178) Avail: NTIS HC/MF A04 CSCL 01/1

This report discusses how the critical velocity of parachutes depends upon the rate of outflow through the canopy surface and the rate of inflow through the canopy mouth. The analysis indicates that the mass flow rate ratio, M', is demonstrated to be the theoretical key to the critical velocity of parachutes. All other observed effects modify the onset of critical velocity. The effects of M' and altitude on inflation reference time, parachute stability, drag coefficient, and inflation rate are also discussed. GRA

N92-19175*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A WEAKLY NONLINEAR THEORY FOR WAVE-VORTEX INTERACTIONS IN CURVED CHANNEL FLOW
BART A. SINGER, GORDON ERLEBACHER (Institute for Computer Applications in Science and Engineering, Hampton, VA.), and THOMAS A. ZANG Mar. 1992 26 p
(NASA-TP-3158; L-16989; NAS 1.60:3158) Avail: NTIS HC/MF A03 CSCL 01/1

A weakly nonlinear theory is developed to study the interaction of Tollmien-Schlichting (TS) waves and Dean vortices in curved channel flow. The predictions obtained from the theory agree well with results obtained from direct numerical simulations of curved channel flow, especially for low amplitude disturbances. Some discrepancies in the results of a previous theory with direct numerical simulations are resolved. Author

N92-19250*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
ON THE INSTABILITY OF BOUNDARY LAYERS ON HEATED FLAT PLATES Final Report
PHILIP HALL and HELEN MORRIS (Exeter Univ., England) May 1991 72 p Submitted for publication
(Contract NAS1-18605)
(NASA-CR-187581; ICASE-91-44; NAS 1.26:187581) Avail: NTIS HC/MF A04 CSCL 01/1

The stability of a boundary layer on a heated flat plate is investigated in the linear regime. The flow is shown to be unstable to longitudinal vortex structures which in general develop in a nonparallel manner in the streamwise direction. Solutions of the nonparallel equations are obtained numerically at 0(1) values of the appropriate stability parameter, i.e., the Grashof number. The particular cases investigated relate to the situations when the instability is induced by localized or distributed wall roughness or nonuniform wall heating. The case when the vortices are induced by freestream disturbances is also considered. The fastest growing mode is found to be governed by a quasi-parallel theory at high wavenumbers. The wavenumber and growth rate of the fastest growing mode are found in closed form. At low wavenumbers the vortex instability is shown to be closely related to Tollmein-Schlichting waves. The effect of wall heating or cooling on the latter type of instability is discussed. Author

N92-19252# Ecole Normale Superieure, Paris (France). Lab. de Spectroscopie Hertzienne.
REACTION SPEED CONSTANT FOR THE REACTIONS BETWEEN N + O2 AND BETWEEN O + N2 [CONSTANTES DE VITESSE DES REACTIONS N + O2 ET O + N2]
N. BILLY, G. GOUEDARD, J. VIGUE, and M. SIZUN (Paris-Sud Univ., Orsay, France) 1991 15 p In FRENCH
(Contract DRET-89-174)
(ETN-92-90861) Avail: NTIS HC/MF A03

The reaction speed constants for the reaction between N and O2 producing NO and O between N2 and O producing NO and N are studied in order to develop a model of hypersonic flow within the Earth's atmosphere. The reaction speeds are calculated using a classic trajectory model. The difficulties involved in carrying out these calculations accurately are presented. The rate determining step of the reactions is calculated for several different energy levels of translation, vibration, and rotation. The reaction rate is then estimated and compared to values found in the literature. ESA

N92-19296# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Military Aircraft Div.
MODELLING OF CHEMICAL AND PHYSICAL EFFECTS WITH RESPECT TO FLOWS AROUND REENTRY BODIES
C. MUNDT and E. H. HIRSCHEL 30 Sep. 1991 15 p Presented at the 3rd Aerospace Symposium, Brunswick, Fed. Republic of Germany, 26-28 Aug. 1991
(MBB-FE-211/S/PUB/0465/A; ETN-92-91000) Copyright Avail: NTIS HC/MF A03

A method which solves the Euler and boundary layer equations for hypersonic, chemical nonequilibrium flows is presented. The high temperature air is modeled by a mixture of five species, each considered to behave as a thermally perfect gas. The transport properties are modeled using the Lennard-Jones potential. Applications are presented for the Hermes configuration. A theoretical comparison, with cases including typical wind tunnel influences such as free stream dissociation, for example, shows the versatility of the method. ESA

N92-19304# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
A COMPARATIVE STUDY OF NUMERICAL VERSUS ANALYTICAL WAVERIDER SOLUTIONS M.S. Thesis
GREGORY O. STECKLEIN Dec. 1991 130 p
(AD-A244183; AFIT/GAE/ENY/91D-26) Avail: NTIS HC/MF A07 CSCL 01/1

The WL/FIMM explicit, Roe flux-splitting Euler algorithm is applied to the inviscid hypersonic flow over a parabolic-top waverider configuration optimized for Mach 10 at zero degrees angle of attack. An on-design grid refinement study is conducted to determine the asymptotic nature of the optimized flight parameter L/D. A parametric study of off-design conditions is conducted to determine flow perturbation effects on HSDT waverider theory. A validation of the Euler code is conducted through a comparison of the numerical data to analytical results derived by Rasmussen. The grid refinement study shows little effect on the inviscid calculation of the optimized parameter L/D. Good agreement with HSDT waverider theory was attained for the on and off-design evaluations. Approximations involved in the numerical modeling of the waverider design produce large losses of lift as compared to the analytical results. Matching of the analytical results was possible only through a theoretical modeling process. GRA

N92-19354*# Arizona State Univ., Tempe.
AERODYNAMIC ROUGHNESS MEASURED IN THE FIELD AND SIMULATED IN A WIND TUNNEL
ROBERT SULLIVAN and RONALD GREELEY Feb. 1992 53 p
(Contract NCC2-346)
(NASA-CR-4422; NAS 1.26:4422) Avail: NTIS HC/MF A04 CSCL 01/1

This study evaluates how well values of aerodynamic surface roughness, z sub 0, measured over scale models in wind tunnels correlate with values of z sub 0 measured at full scale in the

field. A field experiment was conducted in which values of z sub 0 and u* (wind friction speed) were measured over three arrays of non-erodible roughness elements on a dry lake bed. Wind profiles were measured by ten anemometers on a 15 m mast under thermally neutral atmospheric conditions. Values of z sub 0 increased from .00014 m (dry lake bed only) to .026 m with increasing roughness element density. The three roughness element arrays were simulated at 1/10 and 1/20 scale in an open-circuit atmospheric boundary-layer wind tunnel. Velocities were measured with a boundary-layer pitot-tube rake from the same relative position within the scale model arrays as the anemometers were relative to the field arrays. Each array at each scale was sampled three times at five freestream velocities. Average values of z sub 0 for each model array at each scale were compared with full-scale values of z sub 0 obtained in the field. The field vs. wind tunnel correspondence of z sub 0 is found to be z sub 0 field = 0.2661 x (z sub(0 model) x scale(exp -1))exp .8159. Author

N92-19359*# Kansas Univ. Center for Research, Inc., Lawrence. Flight Research Lab.
IDENTIFICATION OF AERODYNAMIC MODELS FOR MANEUVERING AIRCRAFT *Semiannual Status Report, 1 Sep. 1991 - 29 Feb. 1992*
C. EDWARD LAN and C. C. HU 11 Mar. 1992 82 p
(Contract NAG1-1087)
(NASA-CR-190039; NAS 1.26:190039; KU-FRL-872-4) Avail: NTIS HC/MF A05 CSCL 01/1

A Fourier analysis method was developed to analyze harmonic forced-oscillation data at high angles of attack as functions of the angle of attack and its time rate of change. The resulting aerodynamic responses at different frequencies are used to build up the aerodynamic models involving time integrals of the indicial type. An efficient numerical method was also developed to evaluate these time integrals for arbitrary motions based on a concept of equivalent harmonic motion. The method was verified by first using results from two-dimensional and three-dimensional linear theories. The developed models for C sub L, C sub D, and C sub M based on high-alpha data for a 70 deg delta wing in harmonic motions showed accurate results in reproducing hysteresis. The aerodynamic models are further verified by comparing with test data using ramp-type motions. Author

N92-19367# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
INVESTIGATION OF THE INFLUENCE OF ROTARY AERODYNAMICS ON THE STUDY OF HIGH ANGLE OF ATTACK DYNAMICS OF THE F-15B USING BIFURCATION ANALYSIS M.S. Thesis
RALPH D. FERO Dec. 1991 167 p
(AD-A243969; AFIT/GA/ENY/91D-4) Avail: NTIS HC/MF A08 CSCL 01/1

The purpose of this research was to use bifurcation analysis to investigate the effectiveness of rotary balance data in the prediction of aircraft spin behavior as both a stand alone representation of a model's aerodynamic data and in a conventional hybrid model. Using the foundation of a previously developed model of the F-15B, the rotary balance aerodynamic force and moment data were implemented as a function of angle of attack, angle of sideslip, nondimensional rotation steady state rate and the control surface deflections. Bifurcation diagrams were developed as a function of alpha vs. deflection angles of the rudder, stabilator, and aileron to show highlights of equilibrium and dynamic behavior of the aircraft. For selected configurations, the resulting aircraft state variables showed the rotary balance data model having close correlation to experimental flight test data. Comparison of selected configurations with the hybrid and conventional static and forced oscillation models, showed comparable results. However, the models bifurcation diagrams were very different. Problems were identified with static contributions of the rotary balance data indicating a possible cause. The development of the hybrid model displayed the difficulties in blending of the aerodynamic data in the presence of deficient experimental data or inaccurate data modelling. GRA

N92-19394# Army Natick Labs., MA.
DYNAMICAL SYSTEMS ANALYSIS OF AN AERODYNAMIC DECELERATOR'S BEHAVIOR DURING THE INITIAL OPENING PROCESS Final Report, Oct. 1987 - Sep. 1991
LOUIS J. PISCITELLE Dec. 1991 34 p
(Contract DA PROJ. 1L1-61102-AH-52)
(AD-A244194; NATICK/TR-92/017) Avail: NTIS HC/MF A03 CSCL 01/1

A new mathematical model is developed and analyzed to determine the qualitative behavior of an aerodynamic decelerator during the initial opening phase. Currently, all models of canopy opening are valid only once the canopy has begun to inflate and has some assumed shape. The ability to determine the appropriate initial shape would greatly enhance these models. A set of elastodynamic equations for a simplified canopy model is nonlinearly coupled to Lighthill's model for the relative velocity between a cylinder and the flow past it. Previous work used a linear model for the fluid structure interaction. The new model presented in this paper removes this restriction by using a nonlinear interaction model. The resultant set of nonlinear partial differential equations is expended in terms of a complete set of eigenfunctions. The results is an infinite set of coupled ordinary differential equations in time. This set is then truncated to obtain various sets of low-dimensional models. These models are investigated to determine the stability of the canopy with respect to the fluid's velocity, the line tension, and the drag coefficients. Using dynamical system theory, an understanding of the bifurcation process is obtained without having to solve the full system of nonlinear partial differential equations. Hence, it is possible to predict the onset of divergence and flutter as a function of the system parameters in an efficient manner. GRA

N92-19437*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
UNSTEADY-FLOW-FIELD PREDICTIONS FOR OSCILLATING CASCADES
DENNIS L. HUFF 1991 24 p Presented at the Sixth International Symposium on Unsteady Aerodynamics, Aeroacoustics, and Aeroelasticity of Turbomachines and Propellers, Notre Dame, IN, 15-19 Sep. 1991; sponsored by the International Union for Theoretical and Applied Mechanics
(NASA-TM-105283; E-6613; NAS 1.15:105283) Avail: NTIS HC/MF A03 CSCL 01/1

The unsteady flow field around an oscillating cascade of flat plates with zero stagger was studied by using a time marching Euler code. This case had an exact solution based on linear theory and served as a model problem for studying pressure wave propagation in the numerical solution. The importance of using proper unsteady boundary conditions, grid resolution, and time step size was shown for a moderate reduced frequency. Results show that an approximate nonreflecting boundary condition based on linear theory does a good job of minimizing reflections from the inflow and outflow boundaries and allows the placement of the boundaries to be closer to the airfoils than when reflective boundaries are used. Stretching the boundary to dampen the unsteady waves is another way to minimize reflections. Grid clustering near the plates captures the unsteady flow field better than when uniform grids are used as long as the 'Courant Friedrichs Levy' (CFL) number is less than 1 for a sufficient portion of the grid. Finally, a solution based on an optimization of grid, CFL number, and boundary conditions shows good agreement with linear theory. Author

N92-19545*# Texas A&M Univ., College Station. Dept. of Aerospace Engineering.
AN INITIAL INVESTIGATION INTO METHODS OF COMPUTING TRANSONIC AERODYNAMIC SENSITIVITY COEFFICIENTS Semiannual Progress Report, Jul. - Dec. 1991
LELAND A. CARLSON Feb. 1992 78 p

(Contract NAG1-793)
(NASA-CR-190040; NAS 1.26:190040; TAMRF-5802-92-01)
Avail: NTIS HC/MF A05 CSCL 01/1

Research conducted during the period from July 1991 through December 1992 is covered. A method based upon the quasi-analytical approach was developed for computing the aerodynamic sensitivity coefficients of three dimensional wings in transonic and subsonic flow. In addition, the method computes for comparison purposes the aerodynamic sensitivity coefficients using the finite difference approach. The accuracy and validity of the methods are currently under investigation. Author

N92-19623 California Inst. of Tech., Pasadena.
ACTIVE CONTROL OF THE FLOW PAST A CYLINDER EXECUTING ROTARY MOTIONS Ph.D. Thesis
PHILLIP TAKEO TOKUMARU 1991 117 p
Avail: Univ. Microfilms Order No. DA9137297

Experiments were performed on circular cylinders executing forced rotary motions in a steady uniform flow. These motions include harmonic oscillations, steady rotation, and combinations of the two. Flow visualization and laser Doppler velocimetry measurements were used to characterize the wake structure, and to estimate the convection speed, spacing, and strength of the vortical structures. Laser-Doppler velocimetry measurements were also made to estimate the cylinder drag coefficient and wake displacement thickness. Also, the periodic flow close to the cylinder and in the near wake region was mapped for a particular forced case. The data show that a considerable amount of control can be exerted over the flow by such means. In particular, a large increase, or decrease, in the resulting displacement thickness, estimated cylinder drag, and associated mixing with the free stream can be achieved, depending on the frequency and amplitude of oscillation. In order to assess the effects of oscillatory forcing on a cylinder with a net (mean) rotation rate, a novel method for estimating the steady lift forces was used. Using this method, it was also found that the addition of forced rotary oscillations to the steady rotation of the cylinder helped to increase C sub L in the cases where the wake would normally be separated in the steadily rotating case, and decrease it otherwise. Dissert. Abstr.

N92-19679# Cranfield Inst. of Tech., Bedford (England). Dept. of Aerodynamics.
EXPERIMENTAL STUDIES OF VORTEX FLAPS AND VORTEX PLATES. PART 1: 0.53 M SPAN 60 DEG DELTA WING
K. RINOIE (National Aerospace Lab., Tokyo, Japan) and J. L. STOLLERY Aug. 1991 44 p
(CRANFIELD-AERO-9113-PT-1; ISBN-1-871564-33-6; ETN-92-91052) Avail: NTIS HC/MF A03; Cranfield Inst. of Tech., Coll. of Aeronautics, Cranfield, Bedford MK43 OAL, England, HC 8 sterling pounds

Low speed tunnel tests were made to investigate the flow around a leading edge vortex flap at the maximum lift/drag conditions. Tests were also made to measure the performance of the inverted vortex flap and the vortex plate. The force measurements and flow visualization tests were conducted in a 60 degree delta wing model. Results indicate that the lift to drag ratio is a maximum for any given flap deflection angle when the flow comes smoothly onto the deflected vortex flap without forming a large leading edge separation vortex in the flap surface. The benefit of the vortex plate is seen in the drag results which are smaller than those for the datum wing. This benefit is due to some leading edge suction acting on the forward facing region between the delta wing and the vortex plate. ESA

N92-19682# Office National d'Etudes et de Recherches Aerospatiales, Paris (France). Direction de l'Aerodynamique.
DRAG PREDICTION USING COMPUTATION METHODS Final Summary Report [PREVISION DE LA TRAINEE A PARTIR DES METHODES DE CALCUL. RAPPORT DE SYNTHESE FINAL]
J. J. THIBERT, J. L. GODARD, and F. MONTIGNY-RANNOU Feb. 1989 61 p In FRENCH
(Contract DRET-88-34-001)
(ONERA-RSF-82/1685-AY-154-4; ETN-92-91080) Avail: NTIS HC/MF A04

Different two and three dimensional computation methods for the prediction of drag were studied. The integration of pressure was concluded to not allow a correct estimation of the C(sub x) pressure term which is too sensitive to numerous parameters (equations, mesh, convergence, numerical viscosity, etc.). This term can perhaps be evaluated using motion evaluation which gives access to the C(sub x) shock and C(sub x) induced terms. The accuracy thus obtained depends on the evaluation process used and on the numerical method (type of equations, numerical scheme, artificial viscosity, etc.). The best evaluations of viscous effect drag are obtained using wake calculations. The evaluations made show that it is possible to attain accuracy of some 'percent' in the absence of spread detachment. This accuracy level is adapted by adapting the the C(sub x) estimation method to the computation method used. Detail and precise tests in two and three dimensions are necessary to further improve the prediction methods. ESA

N92-19698 Virginia Polytechnic Inst. and State Univ., Blacksburg.
INTEGRATED AERODYNAMIC-STRUCTURAL-CONTROL WING DESIGN Ph.D. Thesis
MASOUD RAIS-ROHANI 1991 136 p
Avail: Univ. Microfilms Order No. DA9201147

The aerodynamic-structural-control design of a simplified wing and forward-swept composite wing are studied. In the first example, the wing is modeled as a beam with a control surface near the wing tip. The torsional stiffness is the only physical property varying along the span. The aerodynamic model is based on strip theory, and the control model is based on output feedback control. With the structural-control interaction being the main focus, two different approaches are taken for the simplified wing design: (1) a sequential approach; and (2) an integrated approach. In each approach, the wing is designed for minimum weight subject to divergence and control deflection constraints. The results indicated that while the integrated approach produced a better design than the sequential approach, the difference was minimal. In the second example, a forward-swept composite wing is designed for a high subsonic transport aircraft. The structural analysis is based on the finite-element method. The aerodynamic calculations are based on the vortex-lattice method, and the control calculations are based on output feedback control. The wing is designed for minimum weight subject to structural, aerodynamic/performance and control constraints. Efficient methods are used to calculate the control deflection and efficiency sensitivities which appear as second order derivatives in the control constraint equations. To suppress the aeroelastic divergence of the forward-swept wing, and to reduce the gross weight of the design aircraft, two separate cases are studied: (1) combined application of aeroelastic tailoring and active controls; and (2) aeroelastic tailoring alone. The results indicated that, for this particular example, aeroelastic tailoring is sufficient for suppressing the aeroelastic divergence, and the use of active controls was not necessary. Dissert. Abstr.

N92-19925# Centre d'Etudes Aerodynamiques et Thermiques, Poitiers (France). Lab. d'Etudes Aerodynamiques.
HYPERSONIC WAKES Final Report [SILLAGES HYPERSONIQUES. RAPPORT FINAL]
M. C. GUEGAN, C. TENAUD, and T. ALZIARY Jul. 1991 72 p In FRENCH
(Contract DRET-89-34-080-00-470-75-01)
(ETN-92-91082) Avail: NTIS HC/MF A04

Experimental studies on transition over a cone in hypersonic regime, and transition in wakes and near wakes, are presented. The experimental wind tunnel setup is described. The code developed for the bottom flow in laminar hypersonic regime is presented. The introduction of turbulence modeling is described. ESA

N92-19993*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
CALCULATIONS OF HOT GAS INGESTION FOR A STOVL AIRCRAFT MODEL
DAVID M. FRICKER, JAMES D. HOLDEMAN, and SURYA P. VANKA (Illinois Univ., Urbana.) 1992 10 p Presented at the 30th Aerospace Sciences Meeting and Exhibit, Reno, NV, 6-9 Jan. 1992; sponsored by AIAA Original contains color illustrations
(NASA-TM-105437; E-6808; NAS 1.15:105437; AIAA-92-0385; AVSCOM-TR-91-C-053) Avail: NTIS HC/MF A02; 5 functional color pages CSCL 01/1

Hot gas ingestion problems for Short Take-Off, Vertical Landing (STOVL) aircraft are typically approached with empirical methods and experience. In this study, the hot gas environment around a STOVL aircraft was modeled as multiple jets in crossflow with inlet suction. The flow field was calculated with a Navier-Stokes, Reynolds-averaged, turbulent, 3D computational fluid dynamics code using a multigrid technique. A simple model of a STOVL aircraft with four choked jets at 1000 K was studied at various heights, headwind speeds, and thrust splay angles in a modest parametric study. Scientific visualization of the computed flow field shows a pair of vortices in front of the inlet. This and other qualitative aspects of the flow field agree well with experimental data. Author

N92-20038*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
INFLUENCE OF AIRFOIL GEOMETRY ON DELTA WING LEADING-EDGE VORTICES AND VORTEX-INDUCED AERODYNAMICS AT SUPERSONIC SPEEDS
RICHARD M. WOOD, JAMES E. BYRD, and GARY F. WESSELMANN (*Arnold Engineering Development Center, Arnold* Air Force Station, TN.) Washington Feb. 1992 86 p
(NASA-TP-3105; L-16851; NAS 1.60:3105) Avail: NTIS HC/MF A05 CSCL 01/1

An assessment of the influence of airfoil geometry on delta wing leading edge vortex flow and vortex induced aerodynamics at supersonic speeds is discussed. A series of delta wing wind tunnel models were tested over a Mach number range from 1.7 to 2.0. The model geometric variables included leading edge sweep and airfoil shape. Surface pressure data, vapor screen, and oil flow photograph data were taken to evaluate the complex structure of the vortices and shocks on the family of wings tested. The data show that airfoil shape has a significant impact on the wing upper surface flow structure and pressure distribution, but has a minimal impact on the integrated upper surface pressure increments. Author

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AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; and aircraft accidents.

A92-25075
DAMPING DOWN THE FIRES
SIMON ELLIOTT Flight International (ISSN 0015-3710), vol. 141, Feb. 5, 1992, p. 46-49.
Copyright

A review is presented of the possible introduction of fire-retarding cabin water-spray systems into civil transport aircraft that may save lives, but with consequent penalties of increased weight, cost, and maintenance. Attention is given to various water-spray development schemes including droplet size, smoke control, flow rate, spray pattern, spray angle, and the viscosity/surface tension, temperature, and specific gravity of the liquid. R.E.P.

A92-25181
A CONSTRAINT SATISFACTION APPROACH TO OPERATIVE MANAGEMENT OF AIRCRAFT ROUTING
FRANCO TORQUATI, MASSIMO PALTRINIERI, and ALBERTO MOMIGLIANO (Bull HN Information Systems Italia S.p.A., Milan, Italy) IN: IEA/AIE-90; Proceedings of the 3rd International *Conference on Industrial and Engineering Applications of Artificial Intelligence and Expert Systems*, Charleston, SC, July 15-18, 1990. Vol. 2. Tullahoma, TN, University of Tennessee, 1990, p. 1140-1146. refs
Copyright

This paper describes the solution to the problem of predictive and reactive aircraft routing developed in OMAR (Operative Management of Aircraft Routing). The basic philosophy is to look at aircraft routing as a constraint satisfaction problem (CSP) and to employ the most effective CSP techniques to solve it under the severe time constraints required by the customer. Author

A92-25521
THE REAL TCAS
KIERAN DALY Flight International (ISSN 0015-3710), vol. 141, Feb. 12, 1992, p. 30-32.
Copyright

An updating is provided of the TCAS traffic alert and avoidance system operational record since the system's introduction four years ago. Primary element reports indicate only a slightly blemished technical success story, qualified but broad support from aircrews, and serious questions from air traffic controllers. R.E.P.

A92-25683#
VOLUME SPECTRA IN SUPERCOOLED CLOUDS FOR SEVERAL RESEARCH FLIGHTS
J. RILEY and D. JECK (FAA, Technical Center, Atlantic City, NJ) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 32 p. refs
(AIAA PAPER 92-0167) Copyright

Droplet volume spectra data from several icing research flights are compared to the Langmuir distributions, the normal distribution, and the gamma distribution. Goodness of fit is assessed by using a simple measure of overall fit, by comparing statistical moments, and, for the Langmuir distributions, by assessing how much of the upper tail of the volume spectrum lies beyond the upper Langmuir boundary. The research flights are drawn from the FAA Atmospheric Aircraft Icing Database. The Langmuir B distribution generally gave the best overall fit of the four Langmuir distributions (although at least a small proportion of the volume spectrum consistently fell beyond the upper boundary of the Langmuir B). The normal distribution usually gave a better fit than the Langmuir B, and the gamma distribution generally gave a better fit than the normal. These flights were not chosen because they are known to be representative and no general conclusions should be drawn from the results for these flights. Author

A92-25743*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
REAL-TIME DECISION AIDING - AIRCRAFT GUIDANCE FOR WIND SHEAR AVOIDANCE
D. A. STRATTON and ROBERT F. STENGEL (Princeton University, NJ) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 9 p. refs
(Contract NAG1-834)
(AIAA PAPER 92-0290) Copyright

Modern control theory and artificial intelligence technology are applied to the Wind Shear Safety Advisor, a conceptual airborne advisory system to help flight crews avoid or survive encounter with hazardous low-altitude wind shear. Numerical and symbolic processes of the system fuse diverse, time-varying data from ground-based and airborne measurements. Simulated wind-shear-encounter scenarios illustrate the need to consider a variety of factors for optimal decision reliability. The wind-shear-encounter simulations show the Wind Shear Safety Advisor's potential for effectively integrating the available

information, highlighting the benefits of the computational techniques employed. Author

A92-25744*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

AIRBORNE IN SITU COMPUTATION OF THE WIND SHEAR HAZARD INDEX

ROSA M. OSEGUERA, ROLAND L. BOWLES (NASA, Langley Research Center, Hampton, VA), and PAUL A. ROBINSON (Lockheed Engineering and Sciences Co., Hampton, VA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 13 p. refs

(AIAA PAPER 92-0291) Copyright

An algorithm for airborne in situ computation of the wind shear hazard index (F-factor) was developed and evaluated in simulation and verified in flight. The algorithm was implemented on NASA's B-737-100 airplane, and tested under severe maneuvering, nonhazardous wind conditions, and normal takeoffs and landings. The airplane was flown through actual microburst conditions in Orlando, FL, where the algorithm produced wind shear measurements which were confirmed by an independent, ground-based radar measurement. Flight test results indicated that the in situ F-factor algorithm correctly measured the effect of the wind environment on the airplane's performance, and produced no nuisance alerts. Author

A92-25749#

ICE PROPERTY/STRUCTURE VARIATIONS ACROSS THE GLAZE/RIME TRANSITION

A. D. REICH (BFGoodrich Aerospace, De-Icing Systems, Uniontown, OH) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 12 p. refs

(AIAA PAPER 92-0296) Copyright

The glaze-rime ice-formation differences were investigated using both analytical and experimental techniques. A dividing 'surface', defined in terms of icing-tunnel control parameters, was obtained. Ice properties were measured using a simple beam deflection system, and icing-tunnel samples were accreted from operating points along a path crossing the dividing surface at a moderate angle. The small signal modulus agreed with previous glaze values and decreased continuously across the transition by a factor of between 2 and 4. The fracture strength showed a similar trend. The density of the samples decreased only slightly (10 percent) crossing the interface. In contrast, the nonlinear creep properties on the rime side of the separating line showed dramatic increases and wide variations in detailed deformation and failure modes as compared to glaze. Author

A92-25750*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

MECHANISMS RESULTING IN ACCRETED ICE ROUGHNESS

ALAN J. BILANIN and KIAT CHUA (Continuum Dynamics, Inc., Princeton, NJ) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 11 p. Research supported by NASA. refs

(AIAA PAPER 92-0297) Copyright

Icing tests conducted on rotating cylinders in the BF Goodrich's Icing Research Facility indicate that a regular, deterministic, icing roughness pattern is typical. The roughness pattern is similar to kernels of corn on a cob for cylinders of diameter typical of a cob. An analysis is undertaken to determine the mechanisms which result in this roughness to ascertain surface scale and amplitude of roughness. Since roughness and the resulting augmentation of the convected heat transfer coefficient has been determined to most strongly control the accreted ice in ice prediction codes, the ability to predict a priori, location, amplitude and surface scale of roughness would greatly augment the capabilities of current ice accretion models. Author

A92-25751#

PROPOSAL FOR A 3-D, VECTORIZED, ADAPTABLE, ALGORITHM FOR MODELING THE RANDOMNESS, UNSTEADINESS, AND MICROPHYSICAL PROPERTIES OF ICE ACCRETION

D. J. YURKANIN (U.S. Navy, Naval Air Engineering Center, Lakehurst, NJ) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 12 p. refs

(AIAA PAPER 92-0299)

A 3D vectorized adaptable algorithm for modeling the microphysics of ice accretion and a method for its implementation on a PC-based interactive graphics/high-speed processor /database system for input/output, organization, and presentation of data are presented. Fundamental arguments are presented concerning cost/benefits of developing such a code and the feasibility of using the algorithm to create a useful upgradable analysis tool. The algorithm is presented in a sequential schematic format where each basic component is described with text and a graphic. Descriptions are given for spray cloud generation characteristics, modularity of the flowfield, trajectory, and accretion codes, and definition of the PC-based systems. New concepts are introduced, such as the dispersion field, bin fields, and bin/accretion type assignment while concentration in the basic unit of accretion, the 'hydrometeor'. Other concerns such as run time optimization and graphics I/O are addressed. P.D.

A92-26359

AIRCRAFT ICING [LE GIVRAGE DES AERONEFS]

DIDIER GUFFOND (ONERA, Direction des Etudes de Synthese, Chatillon, France) (L'Aeronautique et l'Astronautique, no. 148-149, 1991, p. 51-54) ONERA, TP no. 1991-202, 1991, 5 p. In French.

(ONERA, TP NO. 1991-202) Copyright

A review of aircraft icing presented. Systems developed to remove ice deposits or avoid structural ice formations are described. Techniques of modelizing, icing tunnel tests, and flight tests are discussed. Attention is given to computing models utilized to determine ice shapes and to predict the efficiency of antiicing or deicing systems. R.E.P.

A92-26361

AIRCRAFT LIGHTNING STRIKES [LE FOUDROIEMENT DES AVIONS]

JEAN-LOUIS BOULAY (ONERA, Division Environnement Electromagnetique, Chatillon, France) (L'Aeronautique et l'Astronautique, no. 148-149, 1991, p. 45-50) ONERA, TP no. 1991-204, 1991, 7 p. In French. refs

(ONERA, TP NO. 1991-204) Copyright

The global lightning environment for an aircraft was investigated in flight using onboard measurements obtained on the Transall 04 during several lightning events. Attention is given to the different phases of a typical lightning process. A comparison of different data obtained on several aircraft is presented, and the necessity of new simulation tests for aeronautical equipment is discussed. R.E.P.

A92-26949#

DEVELOPMENT OF AN ELECTROTHERMAL DE-ICING/ANTI-ICING MODEL

R. HENRY (ONERA, Chatillon, France) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 9 p. refs

(AIAA PAPER 92-0526) Copyright

A model has been developed to simulate two dimensional heat transfer during deicing and antiicing sequences. Equations are solved in a flat multilayered pad with a nonuniform ice thickness. Phase change is performed by using an enthalpy method. Ice accretion is taken into account with a surface heat and mass balance; ice shedding occurs when the film water at interface exceeds a given value. In antiicing configuration, a complete boundary layer calculation is integrated to consider the effect of heating on the convective transfer. Then, numerical results are compared to previous experimental data. Author

N92-18182# National Aerospace Lab., Tokyo (Japan).
INVESTIGATION ON FREEZING AND STICKING PHENOMENA OF SLUSH ON AIRPLANE SURFACES WHEN TAXIING ON THE GROUND AND THE SUCCEEDING TAKE-OFF RUN PHASE
KINGO TAKAGAWA and FUMIKO ITO Aug. 1989 20 p In JAPANESE; ENGLISH summary
(NAL-TR-1026; ISSN-0389-4010) Avail: NTIS HC/MF A03

An analytical study was conducted on the freezing and sticking phenomena of slush on the horizontal tail surfaces of a twin turboprop transport in the ground taxiing and takeoff run phase. A simple mathematical model describing the outflow of heat from slush to the surrounding airflow through the boundary layer is proposed. Both the conductive heat transfer and the heat transportation accompanied by the evaporation of water from slush are taken into account. The influences upon the heat transfer rate caused by climatic and operational conditions such as the atmospheric temperature, dew point, ground speed, suction coefficient over the horizontal tail surfaces, propeller slip stream effects, and the roughened surface covered by the slush are quantitatively evaluated. Under the climatic conditions occasionally experienced by airline operations in winter, the outflow of heat sufficient to stick the elevators is predicted for the 5-minute ground operation after the starting of the engines and the following 25 second takeoff. During the course of analysis, the conditions which cause, and the factors which accelerate, the freezing of slush are defined. Author

N92-18242# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Fluid Dynamics Panel.
TECHNICAL EVALUATION REPORT ON THE FLUID DYNAMICS PANEL SPECIALISTS' MEETING ON EFFECTS OF ADVERSE WEATHER ON AERODYNAMICS
JOHN J. REINMANN (NASA. Lewis Research Center) and J. W. SLOOFF, ed. (National Aerospace Lab., Amsterdam, Netherlands) Nov. 1991 26 p
(AGARD-AR-306; ISBN-92-835-0646-4) Copyright Avail: NTIS HC/MF A03; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The proceedings of the conference are summarized. The purpose of the meeting was to provide an update of the state of the art with respect to the prediction, simulation, and measurement of the effects of icing, anti-icing fluids and various forms of precipitation on the aerodynamic characteristics of flight vehicles. Sessions were devoted to introductory and survey papers and icing certification issues, to analytical and experimental simulation of ice frost contamination and its effects on aerodynamics, and to the effects of heavy rain and deicing and/or anti-icing fluids. The 19 papers announced for the meeting are published in AGARD CP-496. Author

N92-18259# Walter Kidde Aerospace, Inc., Wilson, NC.
FEASIBILITY OF SYSTEMATIC RECYCLING OF AIRCRAFT HALON EXTINGUISHING AGENTS Final Report, Sep. 1990 - Aug. 1991
MARK D. MITCHELL Dec. 1991 224 p
(Contract DTFA03-90-C-00039)
(DOT/FAA/CT-91/21; REPT-61423) Avail: NTIS HC/MF A10

A study was performed to determine the feasibility of recycling Halon 1301 extinguishing agent for support of the United States civil aircraft fleet until 2020. Research for this study centered around known relationships of refrigerants; the scientific principles of Avogadro, Dalton, Henry, and Raoult; and the physical properties of Halon 1301. Results of the study demonstrate that recovery of Halon 1301 to military specification purity requirements is practical. Agent recovery efficiency of 98 percent (minimum) can be expected, and the recovered agent can meet applicable purity requirements, except for a maximum noncondensible gas content of 10 pounds per square inch partial pressure at 70 F. Support of current and future United States domestic fleet until 2020 and beyond requires less than 5 percent of the projected 1994 Halon 1301 bank. Author

N92-19259# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
GROUND COLLISION AVOIDANCE USING A VARIABLE INCIDENCE ALTITUDE MEASUREMENT SYSTEM FOR THE A-7 AIRCRAFT M.S. Thesis
THOMAS A. HARTUNG Dec. 1991 114 p
(AD-A243880; AFIT/GAE/ENY/91D-15) Avail: NTIS HC/MF A06 CSCL 01/2

This study examines the use of a forward looking sensor in the implementation of an automatic terrain following system. The effect of the incidence angle is studied as well as methodologies to include dynamic motion in the pointing of the sensor beam. The methods examined include fixed angle with respect to the aircraft, dynamics driven by a simple gain, and dynamics directed to gather the terrain information a fixed time interval ahead of the aircraft. Incidence angles of 25, 50, 75, and 90 are examined. The terrain obstacles include a single parabolic hill, a step change in terrain, and a double parabolic hill. Compensator design was accomplished using MATLAB (Trademark) software using Linear Quadratic Gaussian Techniques. State space system realization of the closed loop dynamics were used by a FORTRAN program to run the simulations. Performance was judged by qualitative assessment of flight path, quantitative score of summed distances away from commanded 300 ft AGL altitude, and amount of control power required. The best performance was achieved by the 50 degree incidence angle. Dynamic motion of the sensor beam improved performance but required more control deflection. The best dynamic pointing method was the constant time interval technique. GRA

N92-19276*# FWG Associates, Inc., Tullahoma, TN.
PARTICLE TRAJECTORY COMPUTER PROGRAM FOR ICING ANALYSIS OF AXISYMMETRIC BODIES Final Report
WALTER FROST, HO-PEN CHANG, and KENNETH R. KIMBLE 21 Apr. 1982 121 p
(Contract NAS3-22448)
(NASA-CR-189134; NAS 1.26:189134) Avail: NTIS HC/MF A06 CSCL 01/3

General aviation aircraft and helicopters exposed to an icing environment can accumulate ice resulting in a sharp increase in drag and reduction of maximum lift causing hazardous flight conditions. NASA Lewis Research Center (LeRC) is conducting a program to examine, with the aid of high-speed computer facilities, how the trajectories of particles contribute to the ice accumulation on airfoils and engine inlets. This study, as part of the NASA/LeRC research program, develops a computer program for the calculation of icing particle trajectories and impingement limits relative to axisymmetric bodies in the leeward-windward symmetry plane. The methodology employed in the current particle trajectory calculation is to integrate the governing equations of particle motion in a flow field computed by the Douglas axisymmetric potential flow program. The three-degrees-of-freedom (horizontal, vertical, and pitch) motion of the particle is considered. The particle is assumed to be acted upon by aerodynamic lift and drag forces, gravitational forces, and for nonspherical particles, aerodynamic moments. The particle momentum equation is integrated to determine the particle trajectory. Derivation of the governing equations and the method of their solution are described in Section 2.0. General features, as well as input/output instructions for the particle trajectory computer program, are described in Section 3.0. The details of the computer program are described in Section 4.0. Examples of the calculation of particle trajectories demonstrating application of the trajectory program to given axisymmetric inlet test cases are presented in Section 5.0. For the examples presented, the particles are treated as spherical water droplets. In Section 6.0, limitations of the program relative to excessive computer time and recommendations in this regard are discussed. Author

N92-19350# Institut de Mecanique des Fluides de Lille (France).
AIRPLANE CRASHES ON THE RUNWAY. FINE MODELING OF THE BEHAVIOR AFTER BURNING OF A FRAME SUBMITTED TO LINEAR CRUSHING [CRASH DES AVIONS SUR PISTE. MODELISATION FINE DU COMPORTEMENT POST FLAMBEMENT D'UN CADRE SOUMIS A UN ECRASEMENT LINEIQUE]
E. DELETOMBE and P. GEOFFROY 21 Dec. 1990 68 p In FRENCH
(Contract DRET-86-003-04)
(IMFL-90-64; ETN-92-90868) Avail: NTIS HC/MF A04

A numerical model of the crushing behavior of the frame of a scale model airplane is developed. The model is based on the elastoplastic properties of materials and is shown to be globally and locally accurate on its representation of the real behavior of a crushed frame. This is particularly true of the plastification physics found in the area of plastic bending in accordion-type crushing of the frame. The model is designed to identify the laws governing the macro- or super-elements in order to economically model plastification areas within an actual airplane fuselage. ESA

04

AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

A92-24943
QUANTITATIVE ESTIMATION OF SECONDARY SURVEILLANCE RADAR INFORMATION
D. J. A. WEEDA, L. P. LIGTHART, L. R. NIEUWKERK (Delft University of Technology, Netherlands), and D. C. M. VAN DER KLEIN (Department of Civil Aviation, The Hague, Netherlands) Journal of Navigation (ISSN 0373-4633), vol. 45, Jan. 1992, p. 26-35.
Copyright

Improved radar surveillance for air traffic control can be obtained by the integration of radar systems. Integration, however, might cause the delay of radar information, which would hamper the air traffic controllers in their work. To estimate the delay, a mathematical equation to assess the amount of radar information causing this delay has been deduced from the properties of the behavior of air traffic. The mathematical equation has been tested using results obtained from operational secondary surveillance radar in the Netherlands. Author

A92-24944
THE ACCURACY AND COVERAGE OF LORAN-C AND OF THE DECCA NAVIGATOR SYSTEM - AND THE FALLACY OF FIXED ERRORS
DAVID LAST (University of Wales, Bangor) Journal of Navigation (ISSN 0373-4633), vol. 45, Jan. 1992, p. 36-51. refs
Copyright

The proposal to develop an extensive North-West European Loran-C system, replacing many existing chains of the Decca Navigator System (DNS), has led to an intensive debate on the merits of the two navigation aids, especially in the United Kingdom. The paper reviews the principal sources of random and systematic position errors in the two systems. The wide range of DNS random errors, predominantly due to sky-wave interference, are compared with the Loran-C random errors, and typical coverage limits of acceptable repeatable accuracy are presented. The paper also identifies the factors which control the magnitudes of Loran-C and DNS systematic effects due to land paths. It demonstrates that differences between the two systems are substantially less than are predicted by simple models. Loran-C and DNS techniques for dealing with land paths are compared, and the errors experienced by Loran users are shown to be reduced by modeling and publishing ASF values. This paper is based on a presentation made by the author at a technical symposium of the Wild Goose Association. Author

A92-24945
THE AVOIDANCE OF COLLISIONS FOR NEWTONIAN BODIES WITH HIDDEN VARIABLES
B. D. BRAMSON (Royal Signals and Radar Establishment, Malvern, England) Journal of Navigation (ISSN 0373-4633), vol. 45, Jan. 1992, p. 52-59. refs
Copyright

The collision avoidance of a pair of uniformly moving bodies is considered in three dimensions. The relative motion of the bodies yields an expression relating the time to closest approach, the minimum range, the current range and its rate of change, other variables being unobservable. A Boolean relation is then proposed that is satisfied whenever the minimum range and time to closest approach simultaneously fall below given thresholds. The relation is further studied, in particular with regard to the issue of false and premature alarms. An airborne collision avoidance system is a possible application. Author

A92-24946
EUROPEAN STUDIES TO INVESTIGATE THE FEASIBILITY OF USING 1000 FT VERTICAL SEPARATION MINIMA ABOVE FL 290. II - PRECISION RADAR DATA ANALYSIS AND COLLISION RISK ASSESSMENT
D. HARRISON (Civil Aviation Authority, London, England) and G. MOEK (National Aerospace Laboratory, Amsterdam, Netherlands) Journal of Navigation (ISSN 0373-4633), vol. 45, Jan. 1992, p. 91-106. refs
Copyright

This paper is the second of a series of three papers, documenting the European studies into the feasibility of 1000 ft vertical separation minima above FL 290. The paper discusses the vertical collision risk, estimation methodology, and an assessment of the collision risk against a target level of safety. The analysis indicates the technical feasibility of a reduced vertical separation minima in the North Atlantic Region. However, for current operations and technical performance within European continental airspace, the risk estimation indicates that a 1000 ft minima is not technically feasible. Author

A92-25520
BEHIND THE SCREENS
JULIAN MOXON Flight International (ISSN 0015-3710), vol. 141, Feb. 12, 1992, p. 26-29.
Copyright

An overview is presented of the current status and continuing development of the Central Flow Management Unit (CFMU) to manage the harmonizing and integration of European's ATC and to push the development of an advanced system to replace that in operation today. The initial move towards the CFMU involved rationalizing the existing flow-management units, which meant reducing the 12 ATC centers to five. Attention is given to the three phases of CFMU activity: strategic, pretactical and tactical, the latter stage functioning as closely as possible to the moment of an aircraft's departure, at which time it becomes the responsibility of ATC. Strategic planning covers all activities up to six months prior to an aircraft's departure. R.E.P.

A92-25655
ARINC AND COMMERCIAL AIRCRAFT AVIONICS. I [ARINC Y LA AVIONICA DE LOS AVIONES COMERCIALES. I]
J. C. MEIZOSO Ingenieria Aeronautica y Astronautica (ISSN 0020-1006), no. 326, 1992, p. 21-26. In Spanish.
Copyright

Aeronautical Radio, Inc. (ARINC) was founded in 1929 in order to furnish aircraft radio communications; it encompasses four coordination and development activities committees respectively concerned with: (1) Airlines Electronic Engineering; (2) Avionics Maintenance; (3) Aeronautical Frequencies, and (4) Aviation Coordinating for Telecommunications Services. Attention is

presently given to the rationale for, and implementation of, ARINC's Integrated Modular Avionics System, with the requisite clarifications concerning the concepts of applications software, fail-critical functions, system integrity, reconfiguration, and failure resistance/tolerance. O.C.

A92-26780
HIGH GAIN AIRBORNE ANTENNA FOR SATELLITE COMMUNICATIONS
SHINICHI TAIRA, SHINGO OHMORI, and MASATO TANAKA Communications Research Laboratory, Review (ISSN 0914-9279), vol. 36, no. 10, March 1990, p. 39-46. In Japanese. refs

The development and experimental test results of a high gain airborne antenna for satellite communications are presented. The characteristics of the antenna as installed on a commercial jet aircraft and tested on transoceanic flight routes are described. R.E.P.

A92-26848
NAVIGATION AND FLIGHT MANAGEMENT SYSTEMS - THOUGHTS OF A USER [LES SYSTEMES DE NAVIGATION ET DE GESTION DE VOL - REFLEXIONS D'UN UTILISATEUR]
ANDRE FLEURY (Air France, Paris) (Congres International des Instituts de Navigation, 7th, Cairo, Egypt, Oct. 23-27, 1991) Navigation (Paris) (ISSN 0028-1530), vol. 40, Jan. 1992, p. 27-36. In French.
Copyright

Comments concerning the present widespread use of digital data processing, enabling the synthetic display on cathode ray tubes of navigation and piloting information as well as systems monitoring, are presented. It is noted that, previously, flight deck surfaces (dashboards) were saturated with indicators and dials, whereas now all are replaced by a few screens displaying multiple data. Flight crew observations indicate significant approval of the advanced multiple screen layouts that permit a large amount of flight data to be obtained under a single angle of vision, thus obviating continuous search and eye movement leading to strain and error. R.E.P.

N92-18112# Federal Aviation Administration, Atlantic City, NJ.
VISUAL APPROACH DATA COLLECTION AT SAN FRANCISCO INTERNATIONAL AIRPORT (SFO) Final Report, 9 Nov. 1989 - 12 Mar. 1990
KATHY M. RICHARDS, AMY E. TRANSUE, and DOMINIC TIMOTEO Jan. 1992 49 p
(DOT/FAA/CT-90/23) Avail: NTIS HC/MF A03

Data on aircraft executing simultaneous visual approaches to parallel runways 28R and 29L were collected at San Francisco International Airport (SFO) between 9 Nov. 1989 to 12 Mar. 1990. The purpose of data collection was to analyze the navigational characteristics of aircraft flying the 'fly visual' segment of the approach. Aircraft position data were collected using the in-place Bay Terminal Radar Approach Control Facility (TRACON) Airport surveillance primary and secondary radars. Author

N92-18729# Lancaster Univ. (England). Dept. of Operational Research.
AN EVALUATION OF THE ROYAL AIR FORCE SHORTS TUCANO NAVIGATION INSTRUMENTS TRAINER: THE NAVIT M.S. Thesis
JULIE GOATHAM 1990 73 p Sponsored by Royal Air Force
(ETN-92-90841) Copyright Avail: NTIS HC/MF A04

The Navigation Instruments Trainer (NAVIT) was designed for pre-flying practice of navigation techniques and procedures, in order to alleviate problems encountered with the horizontal situation indicator and the radio magnetic indicator of the high perfornamce turboprop Shorts Tucano, used in the Royal Air Force training program. An evaluation of whether or not the NAVIT was achieving the tasks for which it was designed was made. Alternatives available for future computer based training packages and requiremnts for further evaluation of the NAVIT, when student pilots have continued through the pilot training process to ascertain the long term effects of the NAVIT, are discussed. ESA

N92-18967# Federal Aviation Administration, Washington, DC.
EVALUATION OF ADVANCED MICROWAVE LANDING SYSTEM PROCEDURES IN THE NEW YORK TERMINAL AREA
BARRY C. SCOTT, JIM DARGUE, and TSUYOSHI GOKA (Goka, Tsuyoshi Avionics, Sunnyvale, CA) Dec. 1991 122 p
(DOT/FAA/ND-91/1) Avail: NTIS HC/MF A06

In 1988, the Federal Aviation Administration (FAA) established the Microwave Landing System (MLS) Program Office and initiated a series of projects designed to demonstrate the operational, environmental, and economic benefits of the MLS. The results of the first simulation conducted under the project titled 'Evaluation of Complex MLS Procedures in Multi-Airport Environments' are presented. This initial experiment involved LaGuardia, John F. Kennedy, and Newark airports in the New York Terminal Control Area. Overall, the pilots said that the MLS procedures that were flown were operationally acceptable to them. Speed control was deemed to be very important in that the aircraft should be in final configuration prior to the Precision Final Approach Fix so that the speed would not be changing during the turning portion of the procedure. There was universal agreement that the procedures were much easier to fly than originally anticipated. Author

N92-19041# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.). Inst. fuer Flugfuehrung.
THE COMPAS SYSTEM IN THE ATC ENVIRONMENT
FRED V. SCHICK and UWE VOELCKERS Dec. 1990 164 p Annual DLR Inst. for Flight Guidance Scientific Seminar held in Brunswick, Fed. Republic of Germany, 12-13 Sep. 1990 Original contains color illustrations
(DLR-MITT-91-08; ISSN-0939-298X; ETN-92-90729) Avail: NTIS HC/MF A08; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 60 Deutsche marks

Papers from the 1990 seminar, which focused on a particular Air Traffic Control (ATC) issue, automated planning aids for approach control, are presented. The intention of the seminar was to give a comprehensive view of the development of Computer Oriented Metering Planning Advisory System (COMPAS) and its operational application at the Frankfurt control center (Fed. Republic of Germany) Fundamental principles, operational implementation, field test results, and future plans were covered. ESA

N92-19042# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.).
DESIGN PRINCIPLES OF AUTOMATION AIDS FOR ATC APPROACH CONTROL
UWE VOELCKERS *In its* The COMPAS System in the ATC Environment 11 p Dec. 1990
Avail: NTIS HC/MF A08; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 60 Deutsche marks

During the past decade several automation aids to assist controllers in approach control were developed in Western Europe and the U.S. While the principal functions and elements are very similar in all systems, the different developments show a variety of individual solutions, mostly with regard to the degree of automation, the role of the human controller, the degree of detail of models and algorithms, and the design of the man-machine interface. The design principles and criteria of the Air Traffic Control (ATC) Computer Oriented Metering Planning Advisory System (COMPAS) are presented and compared with other solutions. ESA

N92-19043# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.).
COMPAS SYSTEM CONCEPT
M. SCHUBERT *In its* The COMPAS System in the ATC Environment 19 p Dec. 1990 Original contains color illustrations
Avail: NTIS HC/MF A08; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 60 Deutsche marks

The management of arrival traffic has become one of the most difficult problems in air traffic control. The main objective of the Computer Oriented Metering Planning Advisory System (COMPAS) project was to find solutions and to gain experience in the application of a computer assisted system in the extended approach area. COMPAS was designed to help controllers in their planning and coordination functions and to efficiently merge the arrival traffic into Frankfurt airport (Fed. Republic of Germany). There is a series of models in the system which describe the air traffic control process, the economical flight profiles, the airspace structure plus the analytical method, and models for arrival sequencing. The COMPAS objectives, requirements, and models are described and the controller computer interface of the experimental system is considered in more detail. ESA

N92-19044# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.).
EVALUATION OF THE COMPAS EXPERIMENTAL SYSTEM
FRED V. SCHICK *In its* The COMPAS System in the ATC Environment 17 p Dec. 1990
Avail: NTIS HC/MF A08; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 60 Deutsche marks

For the evaluation of the functional capacity and the operational performance of Computer Aided Metering Planning Advisory System (COMPAS), traffic related aspects and human factors aspects were assessed in a series of experiments at Air Traffic Control (ATC) simulation facilities, with controllers as subjects. The evaluation was done in two major steps. The first step dealt with system layout. It resulted in an optimized design of algorithms, man/machine interface, and control principles of the system, which was in the second step submitted to a large scale evaluation, with more than 100 hours of simulation time. Three sources of data were used: traffic data, operational data of controller work, and controller judgements. The results indicated that COMPAS served as a helpful tool for reducing the effort for approach sequencing and for coordination. The guidance of approach traffic in the terminal area was facilitated by the planning system. ESA

N92-19045# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.).
EXPERIENCES DEVELOPED IN TRANSFERING THE EXPERIMENTAL COMPAS SYSTEM TO AN OPERATIONAL PROTOTYPE VERSION
H.-D. SCHENK *In its* The COMPAS System in the ATC Environment 19 p Dec. 1990 Original contains color illustrations
Avail: NTIS HC/MF A08; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 60 Deutsche marks

To achieve the development and assessment of new systems, procedures and concepts to meet the requirements of the ongoing technical evolution, requires covering the areas from the first idea, to conceptional studies, up to simulations, investigations and assessments in simulated environments. In the development and assessment of the ATC (Air Traffic Control) planning system COMPAS (Computer Oriented Metering Planning Advisory System) the step from transferring the results and outcomes from the experimental investigations into the development of an operational prototype version and its assessment under real operational conditions was undertaken. The special points of interest, problems and experiences found in this process based on the different requirements between the experimental and the operational system and their supporting environments are covered. ESA

N92-19046# ATConsult, Frankfurt (Germany, F.R.).
STEPS TOWARD ACCEPTANCE
K.-H. MINK *In* DLR, The COMPAS System in the ATC Environment 15 p Dec. 1990
Avail: NTIS HC/MF A08; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 60 Deutsche marks

As air traffic controllers will continue to play the main role in Air Traffic Control (ATC), the achievement of acceptance is a prime concern when implementing new ATC system elements. Careful steps of increasing controller participation during all phases of system development and a continuous dialogue with the users is vital for successful implementation. The various steps taken during the COMPAS (Computer Oriented Metering Planning Advisory System) development as well as the lessons learned are described. ESA

N92-19047# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.).
EVALUATION OF THE COMPAS OPERATIONAL SYSTEM
FRED V. SCHICK *In its* The COMPAS System in the ATC Environment 18 p Dec. 1990
Avail: NTIS HC/MF A08; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 60 Deutsche marks

For an evaluation of the operational version of COMPAS (Computer Oriented Metering Planning Advisory Service) in terms of traffic flow, system operation and controller acceptance, a six month field test was carried out. The results indicated that the planning system enabled controllers to establish overall planned approach sequences; thereby contributing to straight and easy traffic flow as well as to the fairness of the final sequences. As regards the impact of COMPAS on controller work, there were distinct results obtained for APPROACH control and for the Area Control Center (ACC). ESA

N92-19048# AEG-Electrocom G.m.b.H., Konstanz (Germany, F.R.).
EXTENSION OF THE FRANKFURT COMPAS FOR GENERAL APPLICATION
W. PARTHIER *In* DLR, The COMPAS System in the ATC Environment 8 p Dec. 1990
Avail: NTIS HC/MF A08; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 60 Deutsche marks

A prerequisite for the maintainability and worldwide marketing of COMPAS (Computer Oriented Metering Planning Advisory System) is a standardized software basis and independence of hardware (e.g., Ada/UNIX). The system basis is outlined and the planned steps to modify the existing COMPAS-OP (adaptation of COMPAS for field tests in Frankfurt, Fed. Republic of Germany) to generate a more or less generally applicable COMPAS are described. ESA

N92-19049# Bundesanstalt fuer Flugsicherung, Frankfurt am Main (Germany, F.R.).
THE IMPACT OF COMPAS ON THE FUTURE COOPERATIVE AIR TRAFFIC MANAGEMENT CONCEPT (CATMAC)
K. PLATZ *In* DLR, The COMPAS System in the ATC Environment 17 p Dec. 1990
Avail: NTIS HC/MF A08; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 60 Deutsche marks

A new concept for the future provision of air traffic services in Germany was developed. The concept is called the Cooperative Air Traffic Management Concept (CATMAC). CATMAC is characterized by improved accuracy and higher reliability of planning data, and by adequate sharing of tasks between automated ground and airborne systems. The experience gained in the development and the operational evaluation of COMPAS (Computer Oriented Metering Planning Advisory System) were of great importance to the definition of the CATMAC concept. ESA

N92-19050# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Brunswick (Germany, F.R.). Inst. for Flight Guidance.
THE ROLE OF PLANNING SYSTEMS IN FUTURE AIR TRAFFIC MANAGEMENT
H. WINTER *In its* The COMPAS System in the ATC Environment 20 p Dec. 1990
Avail: NTIS HC/MF A08; DLR, Wissenschaftliches Berichtswesen,

VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 60 Deutsche marks

In order to increase the productivity of air traffic control, the controllers have to be supported by computers. An analysis of the mental functions performed by the controllers was made and it is proposed to support the subfunction 'planning' by computers. The coupling between the time and space dimensions of planning makes distributed planning necessary. Global strategic and local tactical planning provide a largely conflict free planned traffic which will be monitored and controlled by the controllers. ESA

N92-19391# Federal Aviation Administration, Cambridge, MA. National Transportation Systems Center.

CDI SENSITIVITY AND CROSSTRACK ERROR ON NONPRECISION APPROACHES Final Report, Jun. 1988 - Jun. 1990

M. S. HUNTLEY, JR., CHRISTOPHER J. ROURKE, and ROBERT M. DISARIO Sep. 1991 40 p

(AD-A243981; DOTVNTSC-FAA-91-2; DOT/FAA/RD-91-18)

Avail: NTIS HC/MF A03 CSCL 01/4

This report is concerned with the influence of display needle sensitivity on the accuracy with which pilots can fly nonprecision approaches. Twelve private pilots flew an instrumented single engine airplane on 144 approaches at six different sensitivity levels. The study was conducted to determine the influence of course deviation indicator (CDI) sensitivity on pilot tracking error. The sensitivities ranged from 15,190 feet (2.5 nautical miles) to 475 feet (0.08 nautical miles) for a full-scale deflection. Increase in sensitivity of this magnitude decreased crosstrack Root Mean Square error from an average of 0.22 to 0.04 nautical miles. Magnitude of the error influence of sensitivity on that increases in sensitivity on that magnitude were affected by distance from the missed approach point. Pilots reported that increases in sensitivity increased their-workload and changed their distribution of attention among the aircraft instruments used for navigation and directional control. GRA

N92-19491# National Aerospace Lab., Amsterdam (Netherlands). Informatics Div.

ESTIMATING THE PROBABILITY OF VERTICAL OVERLAP FROM THE PAIRED AIRCRAFT DATA OBTAINED IN THE EUROPEAN VERTICAL DATA COLLECTION USING THE PROGRAM DGLDIF

G. MOEK 8 Jul. 1988 182 p

(Contract RLD-LVB/L-24575)

(NLR-TR-88108-U; ETN-92-90954) Avail: NTIS HC/MF A09

The problem of estimating the probability of vertical overlap in possible future airway systems with a vertical separation standard of 100 ft. above Flight Level 290 is addressed. It forms part of an overall safety assessment of such potential systems. The problem is solved by developing a mathematical probability model of the vertical distance between aircraft in a pair. A priori unknown model parameters are estimated by means of the maximum likelihood method from presently available data in the height keeping performance of aircraft in Europe based on the Double Generalized Laplace (DGL) probability distributions. Special attention is given to the effect on the modeling process of the limited amount of data on large height keeping errors. The point estimate obtained is 0.0000023 to 0.0000066 while an associated 95 pct. interval estimate is 0.0000148. ESA

N92-19604# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

GPS/INS INTEGRATION FOR IMPROVED AIRCRAFT ATTITUDE ESTIMATES M.S. Thesis

DANIEL T. BAGLEY Dec. 1991 242 p

(AD-A243947; AFIT/GE/ENG/91D-04) Avail: NTIS HC/MF A11 CSCL 01/4

This report documents research into the design, implementation, and analysis of a post-mission navigation error estimation algorithm for the Electronic Counter-Countermeasures/Advanced Radar Test Bed (ARTB). In order to quantify the effects of Electronic Countermeasures (ECM) on a given radar accurately, extremely accurate navigation information for ARTB and a given test target must be available for use as reference or truth data. Presently, the ARTB navigation subsystem provides adequate accuracy in position and velocity; however, its computation of attitude does not meet the level of accuracy required for airborne radar flight testing. An extended Kalman filter algorithm is implemented in a filter-driving-filter configuration to integrate the outputs of a Global Positioning System Receiver 3A and a SNU 84-1 Inertial Navigation System in order to estimate and compensate for inertial navigation system errors. The specific objective of integrating the two systems is to enhance the accuracy of ARTB's attitude indications. Outputs from the 12-state GPS Kalman filter simulation are used as measurements in the 23-state Integration Kalman Filter. Monte Carlo simulations are run for measurement update intervals of 5, 10, and 15 seconds, and for both benign (less than 2 G) and highly dynamic (up to 9 G) flight scenarios. Cross-correlation between GPS Kalman filter estimation errors and true INS system errors is also examined. GRA

N92-20029*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

THE CENTER/TRACON AUTOMATION SYSTEM (CTAS): A VIDEO PRESENTATION

STEVEN M. GREEN and JEANNINE FREEMAN (SYRE Corp., Moffett Field, CA.) Jan. 1992 7 p

(NASA-TM-103887; A-91223; NAS 1.15:103887) Avail: NTIS HC/MF A02 CSCL 17/7

NASA Ames, working with the FAA, has developed a highly effective set of automation tools for aiding the air traffic controller in traffic management within the terminal area. To effectively demonstrate these tools, the video AAV-1372, entitled 'Center/TRACON Automation System,' was produced. The script to the video is provided along with instructions for its acquisition. Author

05

AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

A92-24402* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

ON THE THRESHOLD - THE OUTLOOK FOR SUPERSONIC AND HYPERSONIC AIRCRAFT

ROY V. HARRIS, JR. (NASA, Langley Research Center, Hampton, VA) Journal of Aircraft (ISSN 0021-8669), vol. 29, Jan.-Feb. 1992, p. 10-19. Previously cited in issue 21, p. 3267, Accession no. A89-49438. refs

Copyright

A92-24405

AGILITY AS A CONTRIBUTOR TO DESIGN BALANCE

ANDREW M. SKOW (Eidetics Aircraft, Inc., Torrance, CA) Journal of Aircraft (ISSN 0021-8669), vol. 29, Jan.-Feb. 1992, p. 34-46. Previously cited in issue 15, p. 2292, Accession no. A90-35300. refs

Copyright

A92-25013

APPLICATION OF THE MULTIPLIER PENALTY FUNCTION METHOD TO THE OPTIMUM DESIGN OF WING CONFIGURATIONS OF AEROSPACE VEHICLE

JIBIN XU and ZHICHENG HUANG (China Aerodynamics Research and Development Center, Mianyang, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 9, Dec. 1991, p. 477-481. In Chinese. refs

The multiplier penalty function method is utilized to determine

the aerodynamic configurations of a wing which maintains the minimum mass in different center-of-gravity positions, when the requirements of hypersonic trim and low subsonic landing as well as the geometric constraint conditions are satisfied. The computational results emphasize the significance of the optimum design of wing configurations for aerospace vehicles. Author

A92-25074
TILTING AT TARGETS
GRAHAM WARWICK Flight International (ISSN 0015-3710), vol. 141, Feb. 5, 1992, p. 42-45.
Copyright
An overview of tilt-rotor and tilt-wing technology that has been test-flying for some 30 years is presented and the problems facing the developers are discussed. Consideration is given to the V-22 Osprey military tilt-rotor transport, the TW-68 9/14 seat corporate/commuter tilt-wing aircraft, the CL-84 tilt-wing technology demonstrator, and various engine/propeller combinations. R.E.P.

A92-25372
FLUID POWER CONVERSION
JAMES H. BRAHNEY Aerospace Engineering (ISSN 0736-2536), vol. 12, Feb. 1992, p. 15-19.
Copyright
The conversion of fluid power into mechanical motion in the form of force and velocity or torque and rotational speed to move a flight control surface is described. Attention is focused on the actuators that convert hydraulic energy into mechanical energy to perform the system's work. R.E.P.

A92-25502
AN EXPERIMENT ON THE WEIGHT VS CONTROL RELATIONS OF SUBSONIC AIRPLANES
KENJI KARASAWA and KANICHIRO KATO Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 39, no. 455, 1991, p. 651-661. In Japanese. refs
This paper discusses the effect of weight on control and gust responses. A fixed-base flight simulator is used to compare three aircrafts, a microlight airplane, P2V-7, and B-747. The microlight is shown to be difficult to fly in severe winds. Much difference is not seen between P2V-7 and B-747. These results agree with a simplified Bode analysis of the respective aircraft. Author

A92-25687#
OPTIMUM DESIGN OF HELICOPTER ROTOR BLADES WITH MULTIDISCIPLINARY COUPLINGS
ADITI CHATTOPADHYAY and THOMAS R. MCCARTHY (Arizona State University, Tempe) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 10 p. refs
(AIAA PAPER 92-0214) Copyright
The paper addresses the integration of blade dynamics, aerodynamics, structures, and aeroelasticity in the design of helicopter rotors using formal optimization technique. The interaction of the disciplines is studied inside a closed-loop optimization process. The goal is to reduce vibratory shear forces at the blade root with constraints imposed on the dynamic, structural, and aeroelastic design requirements. Both structural and aerodynamic design variables are used. A Minimum Sum beta formulation is used to formulate the multiobjective optimization problem. A nonlinear programming technique and an approximate analysis procedure are used for optimization. Substantial reductions are obtained in the vibratory root forces and moments while satisfying the other design criteria. The results of the optimization procedure are compared with a baseline or reference design. Author

A92-25712*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
INTEGRATED NUMERICAL METHODS FOR HYPERSONIC AIRCRAFT COOLING SYSTEMS ANALYSIS
DENNIS H. PETLEY (NASA, Langley Research Center, Hampton, VA), STUART C. JONES, and WILLIAM M. DZIEDZIC (Lockheed Engineering and Sciences Co., Hampton, VA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 12 p. refs
(AIAA PAPER 92-0254) Copyright
Numerical methods have been developed for the analysis of hypersonic aircraft cooling systems. A general purpose finite difference thermal analysis code is used to determine areas which must be cooled. Complex cooling networks of series and parallel flow can be analyzed using a finite difference computer program. Both internal fluid flow and heat transfer are analyzed, because increased heat flow causes a decrease in the flow of the coolant. The steady state solution is a successive point iterative method. The transient analysis uses implicit forward-backward differencing. Several examples of the use of the program in studies of hypersonic aircraft and rockets are provided. Author

A92-26245#
A METHODOLOGY FOR THE ANALYSIS AND MODELING OF THRUST VECTORING USAGE
A. B. CAIN and P. M. DOANE (McDonnell Aircraft Co., Saint Louis, MO) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 12 p. refs
(AIAA PAPER 92-0389) Copyright
By extending the concepts of descriptive analysis related to turbulence research a computer code is developed that can describe synthetic time histories for pitch and yaw. Time- and frequency-domain data are employed in the computer code for the simulation. 'Equivalent synthetic data sets' are generated with intermittency functions, conditional sampling, spectral densities, four statistical moments, and both auto- and cross-correlations. The pitch- and yaw-vectoring demands of air combat are simulated with the method and found to be independent processes, and the required usage is shown to be non-Gaussian and nonstationary. The technique developed in the paper can be employed to simulate the testing of pitch and yaw thrust-vectoring nozzles and used for comparison with accelerated mission tests to validate the durability of the nozzles. C.C.S.

A92-26550
ELEMENTS OF AIRPLANE PERFORMANCE
G. J. J. RUIJGROK (Delft University of Technology, Netherlands) Delft, Netherlands, Delft University Press, 1990, 461 p. refs
(ISBN 90-6275-608-5) Copyright
A comprehensive account is given of methods for the prediction of aircraft performance. After establishing the application of Newton's law of motion to an earth-related axis system, attention is given to the character of the atmospheric medium, the equations of motion, lift-drag polars, types of aircraft and their propulsion systems, performance in steady symmetric flight, altitude effects, and turning performance. Also treated are gliding flight characteristics, symmetric climb and descent, cruise performance projection, and airfield performance characteristics. O.C.

A92-26849
THE COCKPIT OF A MODERN AIRCRAFT - THE AIRBUS A340 CONSIDERED AS AN EXAMPLE [LE POSTE DE PILOTAGE D'UN AVION MODERNE - EXEMPLE DE L'AIRBUS A340]
J. GROSSIN (Aerospatiale, Toulouse, France) (Congres International des Instituts de Navigation, 7th, Cairo, Egypt, Oct. 23-27, 1991) Navigation (Paris) (ISSN 0028-1530), vol. 40, Jan. 1992, p. 57-69. In French.
Copyright
The A340 and A330 are cited to exemplify the advanced concepts of the modern transport aircraft cockpit. Attention is given to the forward facing crew cockpit, the electronic centralized aircraft monitoring system, the full authority digital engine control, and the radio management panel. Illustrative panels and layouts are provided with descriptions for the FBW system, the maneuver load alleviation system, and the electronic library system. R.E.P.

A92-26950*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
NUMERICAL ANALYSIS OF A THERMAL DEICER
W. B. WRIGHT (Sverdrup Technology, Inc., Brook Park, OH), T.

G. KEITH, JR., and K. J. DEWITT (Toledo, University, OH) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 13 p. Research supported by Ohio Aerospace Institute and NASA. refs
(AIAA PAPER 92-0527)
An algorithm has been developed to numerically model the concurrent phenomena of two-dimensional transient heat transfer, ice accretion and ice shedding which arise from the use of an electrothermal pad. The Alternating Direction Implicit method is used to simultaneously solve the heat transfer and accretion equations occurring in a multilayered body covered with ice. In order to model the phase change between ice and water, a technique was used which assumes a phase for each node. This allows the equations to be linearized such that a direct solution is possible. This technique requires an iterative procedure to find the correct phase at each node. The computer program developed to find this solution has been integrated with the NASA/Lewis flow/trajectory code LEWICE. Author

A92-26951#
IMPROVEMENTS TO EXPULSIVE SEPARATION ICE PROTECTION BLANKETS
JOSHUA GOLDBERG and BENJAMIN LARDIERE, JR. (Dataproducts New England, Inc., Wallingford, CT) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 8 p. refs
(AIAA PAPER 92-0533) Copyright
A number of improvements to expulsive blanket ice shedding capabilities are described. Detailed mechanisms of expulsive blanket ice shedding are discussed. Recent improvements in expulsive system components size and weight are quantified. Author

A92-27394
TRANSGRESSIONS IN A PILOT-HELICOPTER SYSTEM [TRANSGRESJE UKLADU PILOT-SMIGLOWIEC]
KAZIMIERZ SZUMANSKI (Aviation Institute, Warsaw, Poland) Instytut Lotnictwa, Prace (ISSN 0509-6669), no. 126-127, 1991, p. 3-199. In Polish. refs
The transgression concept is used to investigate pilot-helicopter systems in their extreme, near-limit conditions and during their transitions through various operational limits, e.g., connected with catastrophe or breakdown. Helicopter dynamics, the dynamics of the helicopter elements, and steering processes are assessed. Transgression studies combine mathematical modeling with simulator data and empirical flight data. The proposed approach enables the design of a helicopter with improved safety and wider operational range. L.M.

A92-27836
A THEORETICAL STUDY ON HELICOPTER ALERT TIME WITHOUT MAINTENANCE
HAIXIN PENG and JUYUAN ZHOU (Chinese Helicopter Research and Development Institute, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, Oct. 1991, p. B514-B517. In Chinese.
An accurate definition of helicopter alert time without maintenance (tal) is given. The tal concept is studied by using the concept of Q-percentile life. A general method is derived for calculating the tal under the presupposition that alert failure-density functions of the relevant subsystems or components are known and two formulas are obtained. Finally, the basis for determining relevant subsystems or components and the way to realize tal are also presented. Author

A92-27901
THE 'DERIVATIVE' AND 'SYNTHETIC' APPROACHES IN AIRCRAFT DESIGN
BUSHI CHENG (Shanghai Aircraft Research Institute, People's Republic of China) Nanjing Aeronautical Institute, Journal (ISSN 1000-1956), vol. 24, Feb. 1992, p. 1-8. In Chinese.
This paper discusses the problems of inheritance and development, evolution and revolution in aircraft design, and expounds that the 'derivative approach' can be mainly used in the modifications, derivatives, and serial developments of existing prototypes. Applications such as imitation of existing prototypes are limited by historical situations. The correct approach to the aircraft design should be the 'synthetic approach'. Principles the designer should follow are: fulfilling the requirements, wide learning and choosing the appropriate measures, bringing forth new ideas with creative thinking and innovations, and matching individual disciplines together with optimization techniques. Author

A92-27902
THE STABILITY ANALYSIS OF THE NONLINEAR SHIMMY
XUEJUN WANG and XIN QIAO (Nanjing Aeronautical Institute, People's Republic of China) Nanjing Aeronautical Institute, Journal (ISSN 1000-1956), vol. 24, Feb. 1992, p. 9-18. In Chinese. refs
Several nonlinear terms, such as backlash, Coulomb friction and velocity-squared damping in the nonlinear shimmy system, have significant effect on stability. This paper assumes that the top of a nose wheel strut is fixed and gives the complete nonlinear equations used to describe the shimmy system with five degrees of freedom. The described function method is used to analyze the contribution of the above nonlinear terms to the shimmy stability region. The nonlinear equations are transferred into the state space. The amplitude of limit cycle, frequency and the critical parameter curves are determined by optimizing the real part of complex eigenvalues. Meanwhile, this method can extricate designers from the tedious algebraical derivation in the early shimmy stability analysis. For comparison, the corresponding linear shimmy stability is also analyzed. It is shown that the influence of several nonlinear terms in the strut on the shimmy stability region is significant. Because of backlash, the critical taxiing speed of an aircraft decreases greatly. Author

A92-28489
INVESTIGATION ON OPENING AND EJECTION OF AN AIRCRAFT CANOPY BY USING A SOLID ROCKET ENGINE
YUNWU XIE (Northwestern Polytechnical University, Xian, People's Republic of China) Journal of Propulsion Technology (ISSN 1001-4055), Feb. 1992, p. 79-82. In Chinese. refs
An investigation on the opening and ejection of an aircraft canopy in order to save pilot's life in an emergency by using a solid rocket engine is made. The design parameters of SPRM are determined according to the demand of the total project for the aeroplane canopy being ejected. Ground tests verify that the design is practicable and that the performance of the engine can satisfy the demand of the total project. Author

A92-28493
AN AIRLIFTER FOR THE LONG HAUL
RICHARD DEMEIS Aerospace America (ISSN 0740-722X), vol. 30, March 1992, p. 30-33, 39.
Copyright
The C-17 airlifter is evaluated in terms of the use of existing technologies in novel ways as well as its capabilities and potential costs. The C-17 is considered to be less costly in operation than the C-5s and C-141s because it has modern technologies that only require the use of a three-person crew. The C-17 airlift option is noted for the ability to bring outsized loads onto the smaller runways that are found in many small countries. The flight controls incorporate a fly-by-wire system to assist in low-altitude high-speed flying and in steep approaches to short runways. A head-up display, high-lift devices, and four F117 engines round out the technology incorporated into the C-17s to afford the aircraft a wide range of landing configurations. The engine-turbine core and the fan-exhaust flows can be reversed for maneuvering on small ramp areas and for descending in a tactical mode. C.C.S.

N92-18024*# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Aerospace and Ocean Engineering.
HI-ALPHA FOREBODY DESIGN. PART 1: METHODOLOGY BASE AND INITIAL PARAMETRICS Report, 17 Jul. 1989 - 15 Jul. 1990
WILLIAM H. MASON and R. RAVI Jan. 1992 146 p

(Contract NAG1-1037)
(NASA-CR-189849; NAS 1.26:189849; VPI-AERO-176-REV)
Avail: NTIS HC/MF A07 CSCL 01/3

The use of Computational Fluid Dynamics (CFD) has been investigated for the analysis and design of aircraft forebodies at high angle of attack combined with sideslip. The results of the investigation show that CFD has reached a level of development where computational methods can be used for high angle of attack aerodynamic design. The classic wind tunnel experiment for the F-5A forebody directional stability has been reproduced computationally over an angle of attack range from 10 degrees to 45 degrees, and good agreement with experimental data was obtained. Computations have also been made at combined angle of attack and sideslip over a chine forebody, demonstrating the qualitative features of the flow, although not producing good agreement with measured experimental pressure distributions. The computations were performed using the code known as cfl3D for both the Euler equations and the Reynolds equations using a form of the Baldwin-Lomax turbulence model. To study the relation between forebody shape and directional stability characteristics, a generic parametric forebody model has been defined which provides a simple analytic math model with flexibility to capture the key shape characteristics of the entire range of forebodies of interest, including chines. Author

N92-18038*# Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Aerospace and Ocean Engineering.
HI-ALPHA FOREBODY DESIGN. PART 2: DETERMINATION OF BODY SHAPES FOR POSITIVE DIRECTIONAL STABILITY Final Report, 15 Aug. 1990 - 15 Aug. 1991
R. RAVI and WILLIAM H. MASON 2 Feb. 1991 86 p Revised
(Contract NAG1-1037)
(NASA-CR-189850; NAS 1.26:189850; VPI-AERO-182-REV)
Avail: NTIS HC/MF A05 CSCL 01/3

Computational Fluid Dynamics (CFD) has been used to study aircraft forebody flowfields at low speed high angle-of-attack conditions with sideslip. The purpose is to define forebody geometries which provide good directional stability characteristics under these conditions. The flows of the F-5A forebody and Erickson forebody were recomputed with better and refined grids. The results were obtained using a modified version of cfl3d to solve either the Euler equations or the Reynolds equations employing a form of the Baldwin-Lomax turbulence model. Based on those results, we conclude that current CFD methods can be used to investigate the aerodynamic characteristics of forebodies to achieve desirable high angle-of-attack characteristics. An analytically defined generic forebody model is described, and a systematic study of forebody shapes was then conducted to determine which shapes promote a positive contribution to directional stability at high angle-of-attack. A novel way of presenting the results is used to illustrate how the positive contribution arises. Based on the results of this initial parametric study, some guidelines for aerodynamic design to promote positive directional stability are presented. Author

N92-18073# National Aeronautical Lab., Bangalore (India). Flight Mechanics and Controls Div.
DYNAMIC FLYING INVESTIGATIONS ON 1/13.5 NALLA MODEL (LONGITUDINAL RESULTS)
S. BALAKRISHNA, T. NIRANJANA, S. R. RAJAN, and M. S. RAJAMURTHY Jul. 1991 30 p
(Contract NAL PROJ. ID-7-117H)
(NAL-PD-FC-9113) Avail: NTIS HC/MF A03

A 1/13.5 scale National Aeronautical Laboratory Light Aircraft (NALLA) model was instrumented and dynamically flown with one degree of freedom. Experiments were conducted at center of gravity (CG) locations of 0.28 bar-C and 0.43 bar-C. The neutral point of the configuration was shown to be in the range of 0.57 bar-C to 0.58 bar-C, suggesting aft loading. The power effect was shown to be a pitch up above 10 degrees alpha trim and a pitch down below 10 degrees alpha. Author

N92-18096 ESDU International Ltd., London (England).
STATISTICAL METHODS APPLICABLE TO ANALYSIS OF AIRCRAFT PERFORMANCE DATA
Oct. 1991 34 p
(ESDU-91017; ISBN-0-85679-779-0; ISSN-0141-4054) Avail: ESDU

A flowchart is used to guide its user in the application of statistical techniques to the analysis of performance data from which all but random variability has been removed; that is, they have been reduced to standard conditions. The possibility of combining small samples in a larger sample, so improving the accuracy of predictions, is considered. Fisher's Variance Ratio F test is used to decide with a certain confidence whether the samples are from the same population, and Student's t test determines the significance between sample means. Larger samples, exceeding 30 points, either from combined smaller samples or as measured, are treated using Normal distribution statistics provided the Chi squared test for normality with a chosen confidence is met. If the test fails, a transformation of the data (for example, taking the logarithm) may provide a Normal distribution. The use of probability graph paper as a means of analyzing data to the Normal distribution is explained. Regression is considered because, although not a statistical technique, the results are analyzed statistically. The manual calculation of linear two variable regression is discussed, and determination of variance about the regression line, the significance of the regression relationship, regression confidence intervals, and the correlation coefficient and its significance are treated. Multiple linear regression is briefly considered. Tables present the statistics of the Normal distribution, Student's t distribution, the Chi squared distribution and the F distribution. Examples on the use of the methods are found in ESDU 91018 to 91020. ESDU

N92-18333# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Hubschrauber und Flugzeuge.
DESIGN, ANALYSIS, AND TESTING OF INTEGRALLY STIFFENED COMPOSITE CENTRE FUSELAGE SKIN FOR FUTURE FIGHTER AIRCRAFT
L. LEMMER and H. LONSINGER 3 May 1991 21 p Presented at the 8th International Conference on Composite Materials, Honolulu, HI, 15-19 Jul. 1991
(MBB-FE2-PUB-S-450; ETN-92-90614) Copyright Avail: NTIS HC/MF A03

A center fuselage skin made of one piece carbon fiber composite monocoque with double curvature, stiffened with simultaneous curved frames and longerons, is described. The basic design, material selection and stressing of typical features are discussed and compared with test results. The design is assessed in terms of weight reduction and production cost considerations. ESA

N92-18347*# Alabama Univ., Huntsville. Materials Processing Lab.
PROCESS MODELING KC-135 AIRCRAFT Final Report
GARY L. WORKMAN 19 Nov. 1991 38 p
(Contract NAS8-36955)
(NASA-CR-184278; NAS 1.26:184278) Avail: NTIS HC/MF A03 CSCL 01/3

Instrumentation will be provided for KC-135 aircraft which will provide a quantitative measure of g-level variation during parabolic flights and its effect on experiments which demonstrate differences in results obtained with differences in convective flow. The flight apparatus will provide video recording of the effects of the g-level variations on varying fluid samples. The apparatus will be constructed to be available to fly on the KC-135 during most missions. Author

N92-18482# National Aerospace Lab., Tokyo (Japan). Flight Research Div.
A PRELIMINARY FLIGHT TEST ON A BASIC PERFORMANCE OF THE FLIGHT RESEARCH AIRPLANE DO 228: VELOCITY VS GLIDE PATH ANGLE
YOSHIKAZU MIYAZAWA, TAKATSUGU ONO, and YASUHITO

KAWAGOE (Tokyo Denki Univ., Japan) Oct. 1989 18 p
(NAL-TM-613; ISSN-0452-2982; JTN-92-80249) Avail: NTIS HC/MF A03

A preliminary flight test was conducted on the research airplane Dornier Do228-200 that is being modified for use as an in-flight simulator by the National Aerospace Lab (NAL). The basic performance of the aircraft was evaluated by the flight test. Glide path angles were examined with various parameters such as velocity, altitude, and power. The flight test results were compared with those of a mathematical model based on the Dornier GmbH wind tunnel test data. Since an onboard data acquisition system is under development and only primitive measurement is available, accuracy of the flight test is limited. This flight test, however, has verified the mathematical model to some extent, and has given useful data for future flight tests. Author (NASDA)

N92-18571# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Structures and Materials Panel.
FATIGUE MANAGEMENT
Dec. 1991 271 p In ENGLISH and FRENCH The 72d meeting was held in Bath, England, 29 Apr. - 3 May 1991
(AGARD-CP-506; ISBN-92-835-0642-1) Copyright Avail: NTIS HC/MF A12; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

At its seventy-second meeting, the Structures and Materials Panel held a conference of specialists focussing on the problem of fatigue management. Today's trend is to retain aircraft in service much longer than originally planned. This trend, coupled with the facts that airframe structures are much more precisely optimized and advance active control systems are common, makes it essential that state of the art fatigue monitoring procedures are used. Information from such systems is vitally important for efficient, cost effective fleet management. Such data are also important to procurement authorities when trying to plan aircraft replacements.

N92-18572# British Aerospace Public Ltd. Co., Preston (England). Fatigue and Fracture Technology Div.
THE DEVELOPMENT OF FATIGUE MANAGEMENT REQUIREMENTS AND TECHNIQUES
A. P. WARD *In* AGARD, Fatigue Management 4 p Dec. 1991
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Fatigue management requirements and techniques have evolved over a period of 40 years or more. This paper provides an overview of these developments. An historical summary is presented covering the introduction of the different monitoring techniques ranging from the simple V-g recorder through to the multi-channel systems with on-board processing that now exist. The paper concludes with a summary of the main requirements for modern systems and then identifies a number of key issues that should be addressed during the course of the Specialists' Meeting. Author

N92-18574# Veritas Research A.S., Hovik (Norway).
PROBABILISTIC DESIGN AND FATIGUE MANAGEMENT BASED ON PROBABILISTIC FATIGUE MODELS WITH RELIABILITY UPDATING
R. SKJONG, G. SIGURDSSON, and M. K. NYGARD *In* AGARD, Fatigue Management 7 p Dec. 1991
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The fatigue limit state is the governing limit state for an aging airframe. The trend of operating aircraft longer than their originally planned life, calls for extensive testing and inspection. Current practice is to base decisions with respect to inspections and repair on the durability and damage tolerance methodologies. These procedures make little use of probabilistic methods. The paper addresses the same basic problems of similar fundamental models. The formulations are, however, casted into a probabilistic format. In particular the possibility of incorporating new inservice information, based on inspection results or load measurements, is discussed and demonstrated. The advantage of this formulation is illustrated by some examples. Some comments are about future research that would be necessary to fully utilize the capabilities of probabilistic methods. Author

N92-18575# Wright Lab., Wright-Patterson AFB, OH. Structural Integrity Branch.
AGING AIRCRAFT STRUCTURAL DAMAGE ANALYSIS
J. G. BURNS, W. P. JOHNSON, and A. P. BERENS (Dayton Univ. Research Inst., OH.) *In* AGARD, Fatigue Management 15 p Dec. 1991
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The structural problems experienced by aging aircraft, both military and commercial, are described. The programs that are in place in the U.S. Air Force, the research that is being performed, and the facilities that are used to address the problem of aging aircraft are identified. The use of one research product, the computer program PRobability Of Fracture (PROF), describes how current technology can be used to predict damage in aging aircraft structures and the reliability of those structures. Areas where additional research is required are identified and conclusions are drawn. Author

N92-18576# Canadair Ltd., Montreal (Quebec). Military Aircraft Div.
A PROBABILISTIC PROCEDURE FOR AIRCRAFT FLEET MANAGEMENT
Y. THERIAULT and A. R. COLLE *In* AGARD, Fatigue Management 10 p Dec. 1991
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A procedure for determining the probability of structural failure of an airplane at any stage of the operational life is described. This procedure is based on existing models for representing the size distribution of pre-service cracks, the distribution of the maximum service load expected in a single flight, and the reliability of the nondestructive method used for inspection. A case study is presented to show how the procedure can help the fleet manager set more realistic inspection and maintenance schedules and adopt more appropriate retirement policies. Author

N92-18578# National Aeronautical Establishment, Ottawa (Ontario). Structures and Materials Lab.
A PARAMETRIC APPROACH TO SPECTRUM DEVELOPMENT
D. L. SIMPSON, R. J. HISCOCKS, and D. ZAVITZ *In* AGARD, Fatigue Management 16 p Dec. 1991 Sponsored in part by Dept. of National Defence
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The parametric approach being pursued for the development of the test spectrum for the CF-18 center fuselage is described. An overview is provided of the F/A-18 International Follow-on Structural Test Program (IFOSTP) with emphasis on spectrum development. The specific technical elements of the spectrum development task are introduced and detailed information is provided on the CF-18 usage monitoring system, the approach to usage processing and the maneuver identification methodology which is forming the basis of the parametric approach to CF-18 spectrum development. A specific example of the maneuver identification process is provided and recommendations for future monitoring systems are offered. Author

N92-18579# Aerospatiale, Toulouse (France).
FATIGUE TESTING AND TEAR DOWN OPERATIONS ON AIRBUS A320 FORWARD FUSELAGE
R. BOETSCH and J. Y. BEAUFILS *In* AGARD, Fatigue Management 6 p Dec. 1991
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The structural design substantiation of commercial transport aircraft is provided by full static and fatigue analyses supported by testing of complete primary structures. The fatigue and damage tolerance testing on full scale specimen representative of

production aircraft and the teardown inspections performed at the end of the test permit the collection of a lot of data. Main objectives of fatigue tests are to identify weak points in primary structure and to quickly define corrective actions on in-service and production aircraft, and to check the efficiency of the inspection methods, to justify allowable damage and typical repairs of structural repair manuals, to study the propagation of artificial damages which are introduced during the test. The aim of teardown inspections is to verify and validate the inspection methods applied during the test on assembled structure and in addition to find hidden cracks with special nondestructive test methods. Also, from fatigue tests, areas will be found where there is a risk of wide spread fatigue damage and the performance of damage tolerance assessment on the basis of realistic cracking scenarios. Author

N92-18580# Alenia, Torino (Italy). Gruppo Aerei Difesa.
PROPOSAL FOR THE NEW FATIGUE MANAGEMENT SYSTEM FOR THE AMX
P. AMABILE and T. GIACOBBE *In* AGARD, Fatigue Management 9 p Dec. 1991
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The structural monitoring systems produced for the Italian Air Force are briefly presented and discussed. From the previous experience, a new proposal for AMX aircraft monitoring arose and is shown. The proposed system is based mainly on in-flight monitoring of strain gage measurements with storage of some flight parameters for special investigations or simplified back-up analysis in case of failures of the main system. Elaboration methods to be used both on-board and on ground are described. Measurements on static and fatigue tests on ground were studied for a correct tuning of the system. Author

N92-18581# National Defence Headquarters, Ottawa (Ontario). Directorate Aerospace Support Engineering.
DURABILITY AND DAMAGE TOLERANCE TESTING AND FATIGUE LIFE MANAGEMENT: A CF-18 EXPERIENCE
M. B. ZGELA and W. B. MADLEY *In* AGARD, Fatigue Management 16 p Dec. 1991
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Each CF-18 multirole fighter is equipped with a multichannel data acquisition system which records a number of parameters including measured strains, engine data, and various flight incident data. The analysis of this data has enabled the close monitoring of aircraft usage and the rate at which each aircraft accumulated fatigue damage. In 1986, in-service analysis of CF-18 fleet usage indicated that the aircraft were being operated in a significantly different manner than assumed for design, and that severity of the usage approached or exceeded the spectrum used for certification testing. To ensure the maximum economic life of the fleet, a Fatigue Life Management Program (FLMP) was implemented along with Durability and Damage Tolerance Testing activities. The development is described of various components of the FLMP, including the aircrew fatigue awareness program, CF-18 Individual Aircraft Tracking activities, the development and implementation of fatigue damage control measures, and lessons learned from the management of the FLMP. Author

N92-18582# Aeritalia S.p.A., Naples (Italy). Viale dell'Aeronautica.
THE G-222 AIRCRAFT INDIVIDUAL TRACKING PROGRAMME
A. MINUTO, A. APICELLA, A. LANCIOTTI, and L. LAZZERI (Pisa Univ., Italy) *In* AGARD, Fatigue Management 7 p Dec. 1991
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The G-222 is a transport aircraft designed about 20 years ago; from the fatigue point of view, the design is of the conventional 'safe life' kind, verified by means of a full scale test. The aircraft was equipped with a counting accelerometer, whose recordings were used, together with the pilot compiled forms, for the evaluation of life consumption. In recent years, following the Damage Tolerance evaluation of the structure, a different approach has been developed for fatigue damage monitoring; the same input data are used for the prediction of crack growth. The main drawback of this approach is the lack of information about the sequence of load application, so that only non-interactive models can be properly used. For this reason, Aeritalia decided to improve the quality of in-flight recorded parameters, in order to get more data about the actual usage, while also taking the sequence of load application into account. The data acquisition approach is described and discussed. Author

N92-18584# Industrieanlagen-Betriebsgesellschaft m.b.H., Ottobrunn (Germany, F.R.).
AIRCRAFT TRACKING FOR STRUCTURAL FATIGUE
R. NEUNABER *In* AGARD, Fatigue Management 9 p Dec. 1991
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Aircraft tracking is carried out for flight safety reasons, but with an increasing tendency also for economic reasons. With the latter aspect the cost-to-performance ratio becomes more and more important. To take care of both, for the WS Tornado, the parametric data acquisition of the crash recorder was extended to a multi-level tracking concept composed of the sectors temporary aircraft tracking, selected aircraft tracking, and individual aircraft tracking. The key elements of flight monitoring are the flight recorders that are distributed throughout all squadrons on a statistically representative basis and that register operating data for Selected Aircraft Tracking. In the Temporary Aircraft Tracking sector, the recorder parameter set also contains strain gauges in the various fatigue critical areas. Cyclical reading of these strain gauges ensures that any faults are revealed in the parametric algorithms. Individual Aircraft Tracking is carried out on the basis of a reduced pilot parameter set. The data transfer from the aircraft to the evaluation center for this task was converted from manual registration to electronic data processing, increasing the data processing capacity and at the same time significantly improving data quality. Author

N92-18585# Dassault-Breguet Aviation, Saint Cloud (France). Structure Div.
AIRCRAFT TRACKING OPTIMIZATION OF PARAMETERS SELECTION
R. J. CAZES and P. DEFOSSE *In* AGARD, Fatigue Management 12 p Dec. 1991
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Any appropriate structural maintenance plan, based on a Safe-Life or a Damage Tolerance concept, is in close relation with the accuracy of in-service loads identification. The development of multichannel devices with integrated capabilities for in-flight pre-processing allows one to get in-service data and flight results about any critical part of the equipped aircraft, but with sometimes such an amount of computations that the 'should-be simple' in flight processing has to be transferred toward a ground facility. In order to reduce the volume of data for calculations (and their cost of acquisition), we studied the relative influence of the various flight parameters considered during the static and fatigue design of an aircraft. The calculated stresses and loads were compared with their same counterparts measured in flight. Their effects on fatigue values were quantified. This study was performed for the MIRAGE 2000 aircraft tracking and in service loads identification. Author

N92-18586# Deutsche Airbus G.m.b.H., Bremen (Germany, F.R.).
THE OPERATIONAL LOADS MONITORING SYSTEM, OLMS
V. LADDA and H.-J. MEYER *In* AGARD, Fatigue Management 14 p Dec. 1991
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The preservation of the damage tolerance qualities ensures the safe lifelong operation of aircraft. For this purpose and the assessment of fatigue life consumption, different methods have

been developed to monitor the service experiences. Nowadays mainly two kinds of monitoring systems which are different in philosophy exist: first, the parametric system which records and processes only aircraft mission parameters, and second, the direct load/and or stress measurement system using strain gauges. The main advantages and disadvantages of both systems are discussed. A third possibility is to monitor the service experiences of aircraft by combining the advantages of both systems: this leads to the idea of Operational Loads Monitoring System (OLMS). In this contribution the advanced operational loads monitoring system OLMS, for a transport aircraft, is presented. Detailed descriptions are given concerning philosophy and realization. OLMS represents the on-board equipment for the Airframe Condition Monitoring Procedure (ACMP) which takes care of damage tolerance qualities and which will increase the efficiency of structural inspections. The OLMS as presented in this contribution is adaptable to all transport and combat aircraft with electronic flight control systems (EFCS). The verification has been performed on the test aircraft by means of strain gauge measurements. Results of the OLMS-computer simulation program as well as results of the flight test verification are presented. Author

N92-18587# Aeronautical Systems Div., Wright-Patterson AFB, OH.
LIFE MANAGEMENT APPROACH FOR USAF AIRCRAFT
JOHN W. LINCOLN *In* AGARD, Fatigue Management 10 p Dec. 1991
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The USAF Aircraft Structural Integrity Program, that traces its origin to B-47 failures in 1958, was established based on the recognition that repeated loads were a threat to the safety of operational aircraft. Later, it was recognized that manufacturing and in-service damage also had the potential to degrade their safety. This threat has been successfully controlled through the adoption of the damage tolerance approach in 1975. This approach, also referred to as 'retirement for cause,' is used as a basis for an inspection/modification program to maintain safety throughout the lift of the aircraft. However, when the aircraft structure has degraded to the point that multiple site damage has occurred, then the inspection program that was developed for the pristine structure needs to be changed. It is the purpose of this paper to review the occurrences of multiple site damage on USAF aircraft and how this has influenced their lives. This will be done through the experiences derived from the KC-135, C-5 and C-141 aircraft. Author

N92-18588*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
LARGE AREA QNDE INSPECTION FOR AIRFRAME INTEGRITY
WILLIAM P. WINFREE and JOSEPH S. HEYMAN *In* AGARD, Fatigue Management 5 p Dec. 1991
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Quantitative Nondestructive Evaluation (QNDE) technology is being developed to provide new options for cost effective inspection of airframes. An R&D effort based on five NDE technologies is addressing questions of structural bonding assessment, corrosion detection, multisite damage detection, and fatigue characterization. The research/applications are being conducted by prioritized focussing and staging of the following technologies: (1) thermal NDE; (2) ultrasonic NDE; (3) coherent optical NDE; (4) magnetic imaging NDE; and (5) radiographic NDE. The focus here is on the most recent applications of thermal NDE technology to large area inspection of lap-joint and stiffener bonds. The approach is based on pulsed radiant heating of the airframe and measurement of the surface temperature of the structure with an infrared imager. Several advantages of the technique are that it is noncontacting, inspects one square meter area in a period of less than 2 minutes and has no difficulty inspecting typical curvatures of the fuselage. Numerical models of heat flow in these geometries are used to determine appropriate techniques for reduction of the infrared images, thereby delineating regions of disbonds. These models are also used to determine the optimum heating and measurement times for maximizing the contrast between bonded and unbonded structures. Good agreement is found between these results and experimental measurements, and a comparison of the two are presented. Also presented are results of measurements on samples with fabricated defects which show the technique is able to clearly indicate regions of disbonds. Measurements on an airframe also clearly image subsurface structure. Author

N92-18589*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
RECENT FRACTURE MECHANICS RESULTS FROM NASA RESEARCH RELATED TO THE AGING COMMERCIAL TRANSPORT FLEET
CHARLES E. HARRIS *In* AGARD, Fatigue Management 6 p Dec. 1991
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CSCL 01/3

NASA is conducting the Airframe Structural Integrity Program in support of the aging commercial transport fleet. This interdisciplinary program is being worked in cooperation with the U.S. airframe manufacturers, airline operators, and the FAA. Advanced analysis methods are under development to predict the fatigue crack growth in complex built-up shell structures. Innovative nondestructive examination technologies are also under development to provide large area inspection capability to detect corrosion, disbonds, and fatigue cracks. Recent fracture mechanics results applicable to predicting the growth of cracks initiating at the rivets of fuselage splice joints are reviewed. Author

N92-18590# Boeing Commercial Airplane Co., Seattle, WA.
STRUCTURAL AIRWORTHINESS OF AGING BOEING JET TRANSPORTS
JACK F. MCGUIRE and ULF G. GORANSON *In* AGARD, Fatigue Management 10 p Dec. 1991
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Boeing is dedicated to design and manufacture safe commercial jet transports. The successful accomplishment of this responsibility over the last three decades has contributed significantly to a position of industry leadership and reflects the top priority given to safety. This paper illustrates that the structural integrity assurance of commercial airplane structures is a serious and disciplined process. High standards must be maintained to ensure the safety of aging airplanes until economics dictate their retirement. Standard Boeing practices to ensure continuing structural integrity include providing structural maintenance programs, continuous communication through customer support services, and recommendations for maintenance actions through service letters, structural item interim advisories, and service bulletins. To help identify potential problems associated with the aging jet transport fleet, Boeing has implemented additional activities: (1) supplemental structural inspection programs that require airlines to regularly inspect structurally significant items on selected older airplanes and report defects to Boeing for prompt fleet action; (2) teardown of older airframes to help identify corrosion and other structural service defects; (3) fatigue testing of older airframes to determine structural behavior in the presence of service-induced problems such as corrosion and repairs; and (4) an engineering assessment of the condition of a representative sample of older Boeing airplanes to observe effectiveness of corrosion prevention features and acquire additional data that might improve maintenance recommendations to the operators. Aging fleet concerns have also resulted in joint industry, airlines, and airworthiness authority actions. These initiatives have provided timely preventive structural maintenance recommendations and permit continued safe operation of aging jet transports until their retirement from service. Author

N92-18591# Ministry of Defence, London (England).
AIRCRAFT FATIGUE MANAGEMENT IN THE ROYAL AIR FORCE
M. E. J. RENDER and J. E. STEVENS (Royal Air Force, Dereham, England) *In* AGARD, Fatigue Management 14 p Dec. 1991
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An overview of how fatigue is managed for all of the Royal Air Force (RAF) Aircraft Fleets is presented. The main theme is the Tornado Aircraft since it represents the largest portion of the capital value of the RAF inventory. The RAF has three objectives for their aircraft structural integrity policy: to make aircraft operations as safe as is reasonably possible; to ensure that the aircraft are available to the front line; and to minimize the costs. Author

N92-18592# Bundesamt fuer Wehrtechnik und Beschaffung, Munich (Germany, F.R.).
TORNADO STRUCTURAL FATIGUE LIFE ASSESSMENT OF THE GERMAN AIR FORCE
PAUL FRAAS and AMBROS GOELLNER (Industrieanlagen-Betriebsgesellschaft m.b.H., Ottobrunn, Germany, F.R.) *In* AGARD, Fatigue Management 10 p Dec. 1991
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The structural development and the fatigue verification of the Tornado Program was completed. The majority of the aircraft were delivered to the German Air Force and some of them were in full operational use for a period of one decade. This is considered a suitable time to review the approach for ensuring the long-term structural airworthiness, from the users point of view. Author

N92-18593# Portuguese Air Force, Alfragide.
FATIGUE MANAGEMENT FOR THE A-7P
DANIEL SANTOS *In* AGARD, Fatigue Management 19 p Dec. 1991
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One objective of an Aircraft Structural Integrity Program (ASIP) is to ensure that all primary structure is both durable and damage tolerant; that is, it is able to resist both cracking and failure due to cracking. The heart of any durability and damage tolerance assessment is crack growth predictions. This requires a crack growth program, accurate stress intensity and load interaction models, and reliable material properties. With these tools, both durability analysis and damage tolerance analysis can be performed. All potentially critical locations were assumed to exhibit slow crack growth. No fail-safe concepts were used, although many locations have alternate load paths that carry the limit load. Author

N92-18594# Aeronautical Systems Div., Wright-Patterson AFB, OH. Structures Div.
MANAGING AIRBORNE ASSETS THROUGH LOADS MONITORING
R. MACH *In* AGARD, Fatigue Management 12 p Dec. 1991
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Loads monitoring was a cornerstone of the Air Force Structural Integrity Program from its inception. But the high cost of new systems has provided a new need for the program. It provides the hard data that is required by the systems manager to determine the economic life of their aircraft and the most efficient allocation of aircraft to maintain optimum operation capability. Continued advances in solid state microprocessors and integrated software along with advances in storage media should enhance the capability of the overall program. Author

N92-18595# Aeronautical Systems Div., Wright-Patterson AFB, OH. Loads and Dynamics Branch.
APPROACH TO CREW TRAINING IN SUPPORT OF THE USAF AIRCRAFT STRUCTURAL INTEGRITY PROGRAM (ASIP)
ALFONSO G. APONTE *In* AGARD, Fatigue Management 7 p Dec. 1991
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Maintaining the safety and strength of an aircraft is dependent upon the capability of appropriate Air Force commands to perform maintenance and inspections throughout the service life of the aircraft. One of the maintenance actions involves the collection and reporting of operational usage data to support the loads/environment spectra survey (L/ESS) and Individual Aircraft Tracking (IAT) programs. The Air Force approach to training operational flight and ground crews about their responsibilities and the importance of this task which is an integral part of the Aircraft Structural Integrity Program (ASIP) is presented. Author

N92-18778# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Fluid Dynamics Panel.
MANOEUVRING AERODYNAMICS
Nov. 1991 287 p In ENGLISH and FRENCH Meeting held in Toulouse, France, 1-2 May 1991
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This volume contains the 17 papers presented at the Advisory group for Aerospace Research & Development (AGARD) Fluid Dynamics Panel (FDP) Specialists' Meeting on Maneuvering Aerodynamics. In addition to these papers, the general discussion held at the end of the meeting and the Technical Evaluation Report are included. This FDP sponsored meeting and document reflect the growing interests in rapid, large-amplitude aircraft maneuvers at high angles of attack and highlights the importance of the unsteady separated, vortical and often nonlinear characteristics of the aerodynamic flows that exist under such conditions. Developments in pertinent experimental techniques; relevant aerodynamic data and their applications to flight behavior predictions, importance of time lags, methods for forebody vortex control, and flight tests of the X-31A aircraft are among the topics discussed.

N92-18779# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Deutsche Aerospace/Military Div.
X-31 ENHANCEMENT OF AERODYNAMICS FOR MANEUVERING BEYOND STALL
HANNES ROSS *In* AGARD, Manoeuvring Aerodynamics 12 p Nov. 1991
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Current fighter aircraft are generally limited to angles of attack (AOA) below their maximum lift capability. Pilot inputs and aircraft maneuvering usually become limited when approaching the stall limited. Primary reasons for this situation are the degrading aerodynamic lateral/directional characteristics and reduced control power in the high AOA regime, often resulting in uncontrolled maneuvers/departures/spins. For these reasons, some aircraft reduced roll control inputs as well as Aileron-/Rudder-Interconnect (ARI) Systems installed to avoid uncoordinated flight conditions at higher AOA. Others have limitations as to the number of consecutive rolls they are allowed to fly even in the conventional AOA. Others have limitations as to the number of consecutive rolls that are allowed to fly even in the conventional AOA regime to prevent uncontrollable pitch-up/Beta excursions due to inertia coupling and engine gyroscopic moments. In the last ten years, new efforts have started to improve control capability in this flight regime. F-14, F-15, and F-18 have demonstrated AOA excursions up to about 65 degrees and the Su-27 and MIG-29 have performed impressive pitch maneuvers even exceeding AOA's of 90 degrees. However, all of the above mentioned maneuvers are performed in the pitch plane with little or no capability left for role control around the velocity vector. A number of experimental aircraft programs were initiated to explore the high AOA and the poststall regime to broaden the knowledge base. The flight test objectives range from basic understanding and investigation of aerodynamic flow phenomena (X-29, a/c no. 2 high AOA test vehicle, F-18 High AOA Research Vehicle (HARV)) to the incorporation of thrust

vectoring capability (HARV) and finally to the demonstration of technical feasibility and tactical utility of high AOA maneuvering (X-31 A). Author

N92-18780*# Notre Dame Univ., IN. Dept. of Aerospace and Mechanical Engineering.
AERODYNAMIC AND FLOWFIELD HYSTERESIS OF SLENDER WING AIRCRAFT UNDERGOING LARGE-AMPLITUDE MOTIONS
ROBERT C. NELSON, ANDREW S. ARENA, JR., and SCOTT A. THOMPSON *In* AGARD, Manoeuvring Aerodynamics 11 p Nov. 1991
(Contract NCA2-406; NAG1-727; AF-AFOSR-0321-90)
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The implication of maneuvers through large angles of incidence is discussed by examining the unsteady aerodynamic loads, surface pressures, vortical position, and breakdown on slender, flat plate delta wings. Two examples of large amplitude unsteady motions are presented. First, the unsteady characteristics of a 70 degree swept delta wing undergoing pitch oscillation from 0 to 60 degrees is examined. Data is presented that shows the relationship between vortex breakdown and the overshoot and undershoot of the aerodynamic loads and surface pressure distribution. The second example examines the leading edge vortical flow over an 80 degree swept wing undergoing a limit cycle roll oscillation commonly called wing rock. Author

N92-18781# Alenia, Torino (Italy).
PREDICTION OF AERODYNAMIC PHENOMENA LIMITING AIRCRAFT MANOEUVRABILITY
A. FERRETTI, A. BARTOLI, and A. SALVATORE *In* AGARD, Manoeuvring Aerodynamics 10 p Nov. 1991
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The synthesis of recent experiences concerning the effects of shock induced separation on conventional airplanes flying at high subsonic speeds are presented. Efforts were concentrated in synthesizing a prediction criterion for detecting onset of the wing aerodynamic phenomena leading to buffet and mishandling of such airplanes. Comparison of mishandling and buffet onset envelopes theoretically derived with those experimentally measured on an airplane is given evidencing the consistency of the methodology. For nonconventional, highly swept wings featuring leading edge vortical flow at high subsonic speed and moderate angle of attack, the analysis of wind tunnel results has allowed the definition of a prediction criterion for transition from attached to vortical flow. This change in the wing flow structure is responsible for remarkable nonlinearities in the aerodynamic coefficients of the aircraft and could limit maneuverability in certain areas of the flight envelope. Efforts in implementing these concepts in the aerodynamic design process of such wing planforms are stressed as well as the need for further studies concerning a deeper understanding of the fluid dynamic conditions ruling the vortex breakdown. Author

N92-18782# Aeronautica Macchi S.p.A., Varese (Italy). Aerodynamics Dept.
PARAMETRIC EFFECTS OF SOME AIRCRAFT COMPONENTS ON HIGH-ALPHA AERODYNAMIC CHARACTERISTICS
L. VISINTINI, R. PERTILE, and A. MENTASTI *In* AGARD, Manoeuvring Aerodynamics 11 p Nov. 1991
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A wind tunnel test activity was performed with the purpose of defining and understanding the high angle of attack aerodynamic characteristics of an advanced trainer aircraft configuration. The tests included static and rotary balance measurements in the full 0 to 90 degree angle of attack range. The presentation includes a discussion of effects of model breakdown and of forebody finess ratio and cross section. Examples are also given about special difficulties related to subscale high angle of attack wind tunnel testing. Author

N92-18784# General Dynamics Corp., Fort Worth, TX.
ANALYSIS OF UNSTEADY FORCE, PRESSURE, AND FLOW-VISUALIZATION DATA FOR A PITCHING STRAKED WING MODEL AT HIGH ANGLES OF ATTACK
A. M. CUNNINGHAM, JR. and R. G. DENBOER *In* AGARD, Manoeuvring Aerodynamics 16 p Nov. 1991 Prepared in cooperation with National Aerospace Lab., Amsterdam, Netherlands
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Results are presented and discussed for the low speed test of a straked wing model oscillating in pitch that was conducted during 1986. The model was oscillated about mean angles of attack ranging from (-)4 deg to 48 deg with amplitudes varying from 2 deg to 18 deg for a maximum incidence range of (-)8 deg to 50 deg. It was also oscillated in pitch at side slip angles of (+)5 deg and (-)5 deg. Steady and unsteady pressure and flow-visualization data are used to provide a better understanding of the phenomena observed in the aerodynamic characteristics. Author

N92-18785# Royal Aerospace Establishment, Bedford (England). Aerodynamics Dept.
MEASUREMENT OF DERIVATIVES DUE TO ACCELERATION IN HEAVE AND SIDESLIP
C. O. OLEARY, B. WEIR, and J. M. WALKER *In* AGARD, Manoeuvring Aerodynamics 11 p Nov. 1991
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The paper describes the design of a new oscillatory rig, lightweight models, and tests in a low speed wind tunnel. Tests were made over a range of frequencies and model configurations. Derivatives due to acceleration in heave and sideslip, the alpha and beta first derivatives, have been measured for the two High Incidence Research Models (HIRM), HIRM1 and HIRM 2. Dynamic measurements were also made of the 'static' derivatives due to alpha and beta. Results showed that, at high angle-of-attack, derivatives due to acceleration in sideslip, in particular, are large and varied significantly with frequency of oscillation. Effects of model configuration are also presented. Dynamic effects on derivatives due to sideslip angle were significant. Author

N92-18786# Aeronautical Research Inst. of Sweden, Bromma.
WIND TUNNEL FORCE MEASUREMENTS AND VISUALIZATION ON A 60-DEG DELTA WING IN OSCILLATION, STEPWISE MOTION, AND GUSTS
PER-AKE TORLUND *In* AGARD, Manoeuvring Aerodynamics 13 p Nov. 1991
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A 60 deg delta wing has been tested in pitching motion in a low-speed wind tunnel. Harmonic oscillation tests with 4 and 8 deg amplitude at 0 to 35 deg angle of attack were carried out. The reduced frequency was between .003 and .195. Both dynamic aerodynamic derivatives and time histories of the normal force and pitching moment were recorded. The same model was also tested in a stepwise motion up to 90 deg angle of attack. The steps were positive and negative with 20 deg amplitude starting every 10 deg, also steps over the full 90 deg were made. The angle of attack rates were chosen to correspond to the oscillation tests, the maximum being 360 deg/s and the acceleration 13500 deg/s(exp 2). The tunnel speed was 57 m/s in most cases and the centerline chord was .5 m. The response to the step motion was compared to the response predicted from the results of the oscillation tests. Author

N92-18787# Institut de Mecanique des Fluides de Lille (France).
CHARACTERIZATION OF UNSTEADY AERODYNAMIC PHENOMENA AT HIGH ANGLES [CARACTERISATION DE PHENOMENES AERODYNAMIQUES INSTATIONNAIRES A GRANDE INCIDENCE]
O. RENIER *In* AGARD, Manoeuvring Aerodynamics 21 p Nov.

1991 In FRENCH; ENGLISH summary
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Dynamic maneuvers of an aircraft at high angles of attack are known to be the origin of unsteady, large amplitude aerodynamic phenomena. These phenomena cannot be neglected if the control of aircraft attitudes and movements has to be optimized. Such unsteady effects can be characterized on specific wind tunnel test facilities. Already effects of large incidence and sideslip variations of various aircraft geometries have been measured on the IMFL rotary balance during oscillatory coning motions. They have been globally taken into account in mathematical models using transfer functions. An original test apparatus was set up in the IMFL low speed wind tunnel. Various dynamic pitch and/or yaw motions can be carried out on an aircraft model: sinusoidal or constant angular rate motions or typical pointing maneuver attitude evolution. The large performance of this apparatus allows the characterization and analysis of small and large amplitude, high angles of attack aerodynamic phenomena. Those test facilities are described, their dynamic simulation potentialities illustrated by some results and modelization techniques used are presented. Author

N92-18788# Aeronautical Research Labs., Melbourne (Australia).
SCALE MODEL MEASUREMENTS OF FIN BUFFET DUE TO VORTEX BURSTING ON F/A-18
C. A. MARTIN and D. H. THOMPSON *In* AGARD, Manoeuvring Aerodynamics 10 p Nov. 1991
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Tests were carried out on scale models of the F-18 in a wind tunnel and in a water tunnel to study the characteristics of tail buffet due to bursting of the wing leading edge extension (LEX) vortices. The wind tunnel program covered the measurement of unsteady surface pressures and accelerations at the tail of a 1/9th scale model, for cases with and without the LEX fences fitted. Flow visualization of the vortex behavior was carried out using smoke and a laser light sheet. Extensive flow visualization tests were also carried out on a 1/4th scale model in a water tunnel to study the effects of engine intake flow and of the LEX fence on burst characteristics. Various aspects of these test programs are presented. Author

N92-18789# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.).
X-31: DISCUSSION OF STEADY STATE AND ROTARY DERIVATIVES
W. KRAUS *In* AGARD, Manoeuvring Aerodynamics 32 p Nov. 1991
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The X-31A high agility airplane was designed to operate with excellent aerodynamic qualities not only in the normal flight regime, but also at high angles of attack. The aircraft was designed to have natural aerodynamic stability about all three axis in the entire angle of attack range, except at small angle of attack, where the aircraft is unstable in pitch for performance reasons. In some critical regions in which the natural stability cannot be attained, the control power required to achieve stability is provided to the appropriate axis by artificial control, still leaving sufficient control power for maneuvers. In a basic wind tunnel development program, a configuration was tailored which fulfills most of the demanded requirements by aerodynamic means. Both the results and the method of obtaining these results is presented. Besides this static behavior, each aircraft has dynamic characteristics, which decide whether or not the aircraft will diverge. Additional wind tunnel tests was conducted in a spin tunnel to evaluate these characteristics. An analysis of the data is presented including steady state spin modes. Author

N92-18790# British Aerospace Public Ltd. Co., Preston (England). Military Aircraft Div.
USE OF STEPWISE REGRESSION TECHNIQUES AND KINEMATIC COMPATIBILITY FOR THE ANALYSIS OF EAP FLIGHT DATA
A. R. PERKINS *In* AGARD, Manoeuvring Aerodynamics 12 p Nov. 1991
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An investigation is described into the capabilities and accuracy of an equation error method of aerodynamic parameter identification using stepwise regression techniques. The results of the method are presented for flight responses of the British Aerospace EAP aircraft which has multiple control surfaces and high levels of longitudinal instability together with significant nonlinearities in the aerodynamic data. The benefit of kinematic compatibility processing of the flight data is also presented. The EAP flight responses are analyzed up to an incidence of 30 deg using a technique for joining together several maneuvers to form larger data bases for analysis. The derivatives extracted by these techniques agree in general with the results of the wind tunnel measurements. Author

N92-18794# Dornier Luftfahrt G.m.b.H., Friedrichshafen (Germany, F.R.).
TRANSFORMATION OF FLIGHTMECHANICAL DESIGN REQUIREMENTS FOR MODERN FIGHTERS INTO AERODYNAMIC CHARACTERISTICS
PETER MANGOLD *In* AGARD, Manoeuvring Aerodynamics 15 p Nov. 1991
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Recent experience in the design of highly augmented modern fighter aircraft with basically unstable characteristics in pitch have shown that the early integration of flightmechanical requirements into the aerodynamic optimization process is mandatory. Maximum allowable instabilities and control power requirements will set remarkable constraints to the freedom of aerodynamic design and influence essential components of the aircraft. Because of the complex aerodynamic effects at high angles of attack, it will be necessary to approach the 'basic configuration' by some optimization loops. During the whole process, specialists from flight mechanics, aerodynamics, and overall design departments have to form a close team in order to end up with an excellent, well balanced design. It was proven that a set of criteria which represents a platform of common discussion for the specialist groups 'aerodynamics', 'flight mechanics', and control law designers' within early phases of a new fighter project can be and must be established in order to avoid unexpected, time consuming and costly difficulties in later design phases. Author

N92-18826# Diagnostic Equipment Development, Inc., Boca Raton, FL.
CH-46 AND OH-58 TRANSMISSION STRESS WAVE ANALYSIS Final Report
DAVID B. BOARD 30 Dec. 1990 150 p
(Contract N62269-85-R-0278)
(AD-A244321; NADC-91069-60) Avail: NTIS HC/MF A07
CSCL 01/3

This report documents the results of testing on two types of helicopter transmissions. The analysis of high frequency stress wave data indicates various types of problems that were detected with gears and bearings in both CH-46 and OH-58 gear boxes. The types of discrepancies detected include shaft misalignment as a function of flight loads; planet gear/bearing assembly damage; sun gear damage; wear-in phenomena; and the presence of particulate debris in the lubrication system. GRA

N92-19030# Defence Research Establishment Suffield, Ralston (Alberta).
DRES UNMANNED AERIAL VEHICLE DATA LINK RESEARCH Memorandum Report

THOMAS E. OLLEVIER Nov. 1991 31 p
(AD-A244272; DRES-MEMO-1355) Avail: NTIS HC/MF A03
CSCL 01/3

The command and control system of a typical UAV system consists of the airborne command and control system (ACCS), the ground control station (GCS), and the data links required to enable communication between the ACCS and the GCS. This report describes the data links presently used by DRES and the proposed improvements to these systems. It provides background on work carried out in the past with the emphasis on how this work has affected the design of UAV data links at DRES. Requirements of both operational and research UAV data links are also described. The report proposes a possible framework for future research in the area of data links for UAVs including a proposal for research into the feasibility of steerable antennas for UAVs. The work would start with the integration of existing antenna system elements with the UAV autopilot being used as the antenna controller. At the same time work would begin on the design of a steerable antenna with a gain of approx. 10 db. This work would provide a basis for the design of higher gain UAV data link antennas and special purpose antennas such as those required by communications repeaters and sonobuoy repeaters. GRA

N92-19178# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
ANALYSIS OF THE EFFECTS OF REMOVING NOSE BALLAST FROM THE F-15 EAGLE M.S. Thesis
RICHARD L. BENNETT Dec. 1991 82 p
(AD-A244044; AFIT/GA/ENY/91D-1) Avail: NTIS HC/MF A05
CSCL 01/3

This study investigated the results of removing lead ballast from the nose section of the F-15 Air Superiority fighter. The goal of the investigation was to determine if aircraft handling qualities remained acceptable with the ballast removed, and also to determine what improvements in aircraft nose pointing authority resulted. Actual F-15 weight reports were used to calculate the worst case aft center of gravity location shift due to the ballast removal. Several configurations with different center of gravity locations (based on various amounts of lead weights removed) were used for comparison to the baseline aircraft. Moments of inertia were calculated for each configuration, which in turn were used in a 6 degree of freedom computer simulation of the F-15. Simulation test points were then examined throughout the flight envelope of the F-15. Simulation results and better aircraft weight management results support removing (on average) approximately 200 pounds of lead ballast from the nose section of the single seat Air Superiority F-15 Eagle, with a resulting 3 percent increase in pitch rate. A suggested flight test profile is presented for flight verification of the simulation results. GRA

N92-19185# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
ANALYSIS OF AN ADVANCED FIGHTER AIRCRAFT USING JET FLAP TECHNIQUES AND THE VORTEX LATTICE METHOD M.S. Thesis
STEVEN P. SNYDER Dec. 1991 138 p
(AD-A244051; AFIT/GAE/ENY/91D-27) Avail: NTIS HC/MF A07 CSCL 01/1

A computer code using the vortex lattice method with modified boundary conditions was used to determine the induced aerodynamic characteristics of high aspect ratio, vectoring, exhaust nozzles located at the wing root of a canard configured fighter aircraft. Comparison with existing wind tunnel data verified results of the method. The exhaust was modeled as a singularly blown jet flap at deflection angles of -10, 0, 10, 20, 30, and 40 degrees. Jet momentum coefficients were based on gross engine thrust for maximum afterburner and military power settings at a Mach number of 0.6 and an altitude of 20,000 ft. Lift, induced drag, and pitching moment coefficients were calculated for untrimmed conditions. The nozzle provided lift augmentation at all deflections and blowing conditions, a reduction in induced drag at high lift coefficients, and an increased nose down-pitching moment. An optimum flap deflection to achieve minimum induced drag existed for each unique lift and blowing condition. Measurement of the static margin showed that the aircraft as configured was statically unstable. Example cases of comparable wing platforms varying in aspect ratio from 2 to 5 and taper ratio from 0.05 to 1 showed similar behavior. GRA

N92-19192# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
PERFORMANCE AND STABILITY ANALYSIS OF THE NON-LINEAR DYNAMICS OF A SIMPLE POWERED LIFTING HYPERSONIC VEHICLE FLYING ON A MINOR CIRCLE M.S. Thesis
MARK A. ZAVALA Dec. 1991 162 p
(AD-A243933; AFIT/GA/ENY/91D-11) Avail: NTIS HC/MF A08
CSCL 22/3

The nonlinear equations of motion for a hypersonic vehicle flying on a minor circle were modeled using the control design and simulation software package, MATRIXx. The model includes earth rotation and gravity gradient effects. Aerodynamic forces and moments are expressed as first order Taylor series expansions using the full nonlinear expression for the dynamic pressure. Minor circle equilibrium flight conditions are generated via a Newton iteration technique (Turbo Pascal program) for both a rotating and non-rotating earth model. Equilibrium performance over speeds from Mach 5 to Mach 40 and 0 to 85 degree latitudes at east and west flight headings are compared. The speed and latitude determine equilibrium bank angles, altitude, and roll, pitch, and yaw control moments (to sustain minor circle flight). These parameters are analyzed to assess equilibrium performance. Results show that earth rotation and gravity gradient torques have significant effects on performance. The system is shown (via MATRIXx) to be marginally unstable. For near-major circle routes, the modes are poorly damped and decoupled into lateral and longitudinal modes. For mid-latitude minor circle routes, the modes are poorly damped and coupled. However, the modes are comprised of either mostly longitudinal or mostly lateral states. For minor circle latitudes greater than 65 deg, we see poorly damped coupled modes, with new mode shapes appearing as equilibrium speeds increase. GRA

N92-19225# Aix-Marseilles Univ. (France). Inst. de Mecanique Statistique de la Turbulence.
HOT JET DILUTOR Final Summary Report [DILUEUR DE JET CHAUD. RAPPORT DE SYNTHESE FINALE]
M. AMIELH and M. P. CHAUVE Feb. 1991 105 p In FRENCH
(Contract DRET-89-169)
(ETN-92-90860) Avail: NTIS HC/MF A06

The hot gases produced by the exhaust of helicopters produce a very visible infrared signature. A hot jet dilutor is proposed as a means of reducing this infrared signature. Various two dimensional hot jet dilutor geometries are studied. Data generated by these models is used to validate calculation codes to be used in simulating flows in various ejector configurations in order to optimize their operation. The experimental methods and techniques used are described in detail. ESA

N92-19374*# Notre Dame Univ., IN. Dept. of Aerospace and Mechanical Engineering.
KAPPA GROUP: THE INITIAL GUESS. A PROPOSAL IN RESPONSE TO A COMMERCIAL AIR TRANSPORTATION STUDY Final Design Proposal
May 1991 88 p Sponsored in part by Boeing Commercial Airplane Co.
(Contract NASW-4435)
(NASA-CR-189981; NAS 1.26:189981) Avail: NTIS HC/MF A05
CSCL 01/3

Kappa Aerospace presents their Aeroworld Aircraft, the Initial Guess (IG). This aircraft is designed to generate profit in the market which is currently controlled by the train and boat industry. The main priority of the design team was to develop an extremely efficient aircraft that could be sold at a reasonable price. The IG offers a quick and safe alternative to the existing means of

transportation at a competitive price. The cruise velocity of 28 ft/sec. allows all flights to be between 20 and 45 minutes, which is a remarkable savings in time compared to travel by boat or train. The IG is propelled by a single Astro-05 engine with a Zinger 10-6 propeller. The Astro-05 is not an extremely powerful engine; however, it provides enough thrust to meet the design and safety requirements. The major advantage of the Astro-05 is that it is the most efficient engine available. The fuel efficiency of the Astro-05 is what puts the aircraft ahead of the competition. The money saved on an efficient engine can be passed on as lower ticket prices or increased revenue. The IG has a payload of 56 passengers and a wingspan of 7 ft. The 7 ft. wingspan allows the aircraft to fit into the gates of all of the cities that are targeted. Future endeavors of Kappa Aerospace will include fitting a stretch version of the IG with a larger propulsion system. This derivative aircraft will be able to carry more passengers and will be placed on the routes which have the greatest demand for travel. The fuselage and empennage are made of a wooden truss configuration, while the wing is made of a rib/spare configuration. The stress carrying elements are made of spruce, the nonstress carrying elements are made of balsa. The wing is removable for easy access into the fuselage. The easy access to the batteries will keep maintenance costs down. Author

N92-19496*# California Polytechnic State Univ., San Luis Obispo.
PROPOSAL FOR A LOW COST CLOSE AIR SUPPORT AIRCRAFT FOR THE YEAR 2000: THE RAPTOR
JEROME D. BROWN, WARD S. DEWITT, MARK MCDONALD, JOHN W. RILEY, ANTHONY E. ROBERTS, SEAN WATSON, and MARGARET M. WHELAN 10 May 1991 83 p
(Contract NASW-4435)
(NASA-CR-190023; NAS 1.26:190023) Avail: NTIS HC/MF A05 CSCL 01/3

The Raptor is a proposed low cost Close Air Support (CAS) aircraft for the U.S. Military. The Raptor incorporates a 'cranked arrow' wing planform, and uses canards instead of a traditional horizontal tail. The Raptor is designed to be capable of responsive delivery of effective ordnance in close proximity to friendly ground forces during the day, night, and 'under the weather' conditions. Details are presented of the Raptor's mission, configuration, performance, stability and control, ground support, manufacturing, and overall cost to permit engineering evaluation of the proposed design. A description of the design process and analysis methods used is also provided. Author

N92-19563*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
TILTROTOR RESEARCH AIRCRAFT COMPOSITE BLADE REPAIRS: LESSONS LEARNED
PAUL S. ESPINOSA and DAVID R. GROEPLER Dec. 1991 20 p Presented at the Eighth International Conference on Composite Materials, Honolulu, HI, Jul. 1991
(NASA-TM-103875; A-91189; NAS 1.15:103875) Avail: NTIS HC/MF A03 CSCL 01/3

The XV-15, N703NA Tiltrotor Research Aircraft located at the NASA Ames Research Center, Moffett Field, California, currently uses a set of composite rotor blades of complex shape known as the advanced technology blades (ATBs). The main structural element of the blades is a D-spar constructed of unidirectional, angled fiberglass/graphite, with the aft fairing portion of the blades constructed of a fiberglass cross-ply skin bonded to a Nomex honeycomb core. The blade tip is a removable laminate shell that fits over the outboard section of the spar structure, which contains a cavity to retain balance weights. Two types of tip shells are used for research. One is highly twisted (more than a conventional helicopter blade) and has a hollow core constructed of a thin Nomex-honeycomb-and-fiberglass-skin sandwich; the other is untwisted with a solid Nomex honeycomb core and a fiberglass cross-ply skin. During initial flight testing of the blades, a number of problems in the composite structure were encountered. These problems included debonding between the fiberglass skin and the honeycomb core, failure of the honeycomb core, failures in fiberglass splices, cracks in fiberglass blocks, misalignment of mated composite parts, and failures of retention of metal fasteners. Substantial time was spent in identifying and repairing these problems. Discussed here are the types of problems encountered, the inspection procedures used to identify each problem, the repairs performed on the damaged or flawed areas, the level of criticality of the problems, and the monitoring of repaired areas. It is hoped that this discussion will help designers, analysts, and experimenters in the future as the use of composites becomes more prevalent. Author

N92-19701 Cranfield Inst. of Tech., Bedford (England).
A STUDY OF THE AEROELASTIC BEHAVIOUR OF HELICOPTER ROTOR BLADES FEATURING SWEPT TIPS Ph.D. Thesis
R. H. MARKIEWICZ 1990 302 p
Avail: Univ. Microfilms Order No. BRDX93762

The design of a model helicopter rotor blade incorporating a swept tip is described. The swept tip is chosen to provide a coupling between the lift at the tip and the blade twist, thus achieving a variation of blade twist with azimuth and with forward speed. The design is the first step in an investigation of aeroelastic tailoring as a means of reducing helicopter vibration and increasing rotor performance. The first prototype blade encountered stability problems and further designs were evaluated using a new modes/stability computer program developed within RAE. Comparisons are made between the stresses measured on a second stable swept tip blade and a dynamically similar rectangular blade. The results show that a beneficial twisting of the swept tip blade is achieved which enhances rotor performance and reduces the flatwise bending and torsional moments. Comparisons are made between the experimental results and those predicted by the RAE/WHL for the flatwise moments, but a more representative model of the hub is needed to produce acceptable predictions of the torsional moments. The design of a further set of blades is discussed, the aim being to investigate the effects of introducing a strong coupling between the flap and torsion motions of the blade by sweeping back the shear center. An analysis of the results shows that there are large gains in blade stability with no severe adverse effects on blade loads. A theoretical investigation was undertaken to observe the effects of tip sweep on the performance of a full size rotor. The results show that aft tip sweep can reduce control loads and rotor power for a rotor with a cambered aerofoil section. Dissert. Abstr.

N92-19846*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
OPTIMIZING TUNING MASSES FOR HELICOPTER ROTOR BLADE VIBRATION REDUCTION INCLUDING COMPUTED AIRLOADS AND COMPARISON WITH TEST DATA
JOCELYN I. PRITCHARD, HOWARD M. ADELMAN, JOANNE L. WALSH, and MATTHEW L. WILBUR Jan. 1992 11 p Presented at the 33rd Structures, Structural Dynamics, and Materials Conference, Dallas, TX, 13-15 Apr. 1992
(Contract DA PROJ. 1L6-2211-A-47-AA)
(NASA-TM-104194; AVSCOM-TR-91-B-020; NAS 1.15:104194) Avail: NTIS HC/MF A03 CSCL 01/3

The development and validation of an optimization procedure to systematically place tuning masses along a rotor blade span to minimize vibratory loads are described. The masses and their corresponding locations are the design variables that are manipulated to reduce the harmonics of hub shear for a four-bladed rotor system without adding a large mass penalty. The procedure incorporates a comprehensive helicopter analysis to calculate the airloads. Predicting changes in airloads due to changes in design variables is an important feature of this research. The procedure was applied to a one-sixth, Mach-scaled rotor blade model to place three masses and then again to place six masses. In both cases the added mass was able to achieve significant reductions in the hub shear. In addition, the procedure was applied to place a single mass of fixed value on a blade model to reduce the hub shear for three flight conditions. The analytical results were compared to experimental data from a wind tunnel test performed

in the Langley Transonic Dynamics Tunnel. The correlation of the mass location was good and the trend of the mass location with respect to flight speed was predicted fairly well. However, it was noted that the analysis was not entirely successful at predicting the absolute magnitudes of the fixed system loads. Author

N92-19847*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
A MATHEMATICAL MODEL OF A TILT-WING AIRCRAFT FOR PILOTED SIMULATION
JOSEPH J. TOTAH Jan. 1992 15 p
(NASA-TM-103864; A-91150; NAS 1.15:103864) Avail: NTIS HC/MF A03 CSCL 01/3

A mathematical model of a tilt-wing aircraft that was used in a piloted, six-degree-of-freedom flight simulation application is described. Two types of control systems developed for the math model are discussed: a conventional, programmed-flap wing-tilt control system and a geared-flap wing-tilt control system. The primary objective was to develop the capability to study tilt-wing aircraft. Experienced Tilt-wing pilots subjectively evaluated the model using programmed-flap control to assess the quality of the simulation. The math model was then applied to study geared-flap control to investigate the possibility of eliminating the need for auxilary pitch-control devices (such as the horizontal tail rotor or tail jet used in earlier tilt-wing designs). This investigation was performed in the moving-base simulation environment, and the vehicle responses with programmed-flap and geared-flap control were compared. The results of the evaluation of the math model are discussed. Author

N92-19871*# Douglas Aircraft Co., Inc., Long Beach, CA.
AN EXPLORATION OF FUNCTION ANALYSIS AND FUNCTION ALLOCATION IN THE COMMERCIAL FLIGHT DOMAIN Final Report
JAMES C. MCGUIRE, JOHN A. ZICH, RICHARD T. GOINS, JEFFERY B. ERICKSON, JOHN P. DWYER, WILLIAM J. CODY, and WILLIAM B. ROUSE (Search Technology, Inc., Norcross, GA.) Washington NASA Nov. 1991 364 p
(Contract NAS1-18028)
(NASA-CR-4374; NAS 1.26:4374) Avail: NTIS HC/MF A16 CSCL 01/3

The applicability is explored of functional analysis methods to support cockpit design. Specifically, alternative techniques are studied for ensuring an effective division of responsibility between the flight crew and automation. A functional decomposition is performed of the commercial flight domain to provide the information necessary to support allocation decisions and demonstrate methodology for allocating functions to flight crew or to automation. The function analysis employed 'bottom up' and 'top down' analyses and demonstrated the comparability of identified functions, using the 'lift off' segment of the 'take off' phase as a test case. The normal flight mission and selected contingencies were addressed. Two alternative methods for using the functional description in the allocation of functions between man and machine were investigated. The two methods were compared in order to ascertain their relative strengths and weaknesses. Finally, conclusions were drawn regarding the practical utility of function analysis methods. Author

06

AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

A92-24575
OPTICAL VELOCITY SENSOR FOR AIR DATA APPLICATIONS
ANTHONY E. SMART (Titan Corp., Spectron Div., Costa Mesa, CA) Optical Engineering (ISSN 0091-3286), vol. 31, Jan. 1992, p. 166-173. Research supported by Titan Corp. refs
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An optical velocity sensor, based on the sheet-pair transit-time technology, was designed, built to flightworthy standards, and test flown on an F-16B to 50,000 ft and Mach 1.2, as part of an optoavionic air data system. Brief descriptions of the work leading to 24 flights in January and February 1990 are given, with examples of data and discussions of experiences. Compared with conventional pneumatic sensors the system offers advantages that include potential improvements in accuracy, latency, calibration, dynamic range of speed and attitude, robustness, and possibly life, cost, and range of application, without modification of the vehicle skin contour. Measurements corresponding well with the aircraft system were obtained under all conditions except heavy cloud, which demands small design changes for future systems. The importance of modeling for software and hardware design optimization is stressed and measurements are presented. Author

A92-24781
PROGRESS TOWARDS FIBER OPTIC SMART STRUCTURES AT UTIAS
RAYMOND M. MEASURES (Toronto, University; Ontario Laser and Lightwave Research Centre, Downsview, Canada) IN: Fiber optic smart structures and skins III; Proceedings of the Meeting, San Jose, CA, Sept. 19-21, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 46-68. Research supported by Ontario Laser and Lightwave Research Centre, NSERC, Institute for Space and Terrestrial Science, et al. refs
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An overview of the advances toward the development of fiber optic based smart structures will be presented, including the work on the development and testing of an aircraft wing leading edge with a structurally integrated fiber optic damage assessment system, the development and testing of a Fabry-Perot strain rosette, studies of acoustic emission within composites materials detected by embedded fiber optic sensors and a comparison of sensory and vision based structural deformation systems. Author

A92-24785
SMART SKINS AND FIBER-OPTIC SENSORS APPLICATION AND ISSUES
KAUSAR TALAT (Boeing Defense and Space Group, Military Airplanes Div., Seattle, WA) IN: Fiber optic smart structures and skins III; Proceedings of the Meeting, San Jose, CA, Sept. 19-21, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 103-114. refs
Copyright

Smart skins technology is in its infancy, and significant work must be accomplished to ensure that evolving fiber-optic sensor technology can be incorporated into smart skins concepts. This paper gives an overview of research into embedding optical fibers and sensors in composites. It also presents a concept for a fiber-optic sensor network embedded in aircraft skins to perform structural health monitoring and discusses issues, problems, and potential solutions encountered in bringing multiple technologies together. Author

A92-24918
A NEW THERMOMETRIC INSTRUMENT FOR AIRBORNE MEASUREMENTS IN CLOUDS
KRZYSZTOF E. HAMAN (Warsaw, University, Poland) Journal of Atmospheric and Oceanic Technology (ISSN 0739-0572), vol. 9, Feb. 1992, p. 86-90. Research supported by Polish Academy of Sciences. refs
Copyright

A new instrument for measuring the temperature of air in clouds from an aircraft is described. The instrument uses a very fine thermometric sensor located behind a thin rod that protects the sensor from direct contact with cloud droplets. Because the airflow is less disturbed than in more massive protective housings, the accuracy and speed of the sensor are relatively less affected

than in other types of airborne contact thermometers. Details of the construction of a prototype unit and results of preliminary flight and wind tunnel tests are given. Author

A92-25719*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
FAILURE DETECTION AND FAULT MANAGEMENT TECHNIQUES FOR FLUSH AIRDATA SENSING SYSTEMS
STEPHEN A. WHITMORE, TIMOTHY R. MOES (NASA, Flight Research Center, Edwards, CA), and CORNELIUS T. LEONDES (Washington, University, Seattle) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 22 p. refs
(AIAA PAPER 92-0263) Copyright

Methods based on chi-squared analysis are presented for detecting system and individual-port failures in the high-angle-of-attack flush airdata sensing system on the NASA F-18 High Alpha Research Vehicle. The HI-FADS hardware is introduced, and the aerodynamic model describes measured pressure in terms of dynamic pressure, angle of attack, angle of sideslip, and static pressure. Chi-squared analysis is described in the presentation of the concept for failure detection and fault management which includes nominal, iteration, and fault-management modes. A matrix of pressure orifices arranged in concentric circles on the nose of the aircraft indicate the parameters which are applied to the regression algorithms. The sensing techniques are applied to the F-18 flight data, and two examples are given of the computed angle-of-attack time histories. The failure-detection and fault-management techniques permit the matrix to be multiply redundant, and the chi-squared analysis is shown to be useful in the detection of failures. C.C.S.

A92-25724*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
COMPREHENSIVE HELICOPTER ROTOR INSTRUMENTATION - A RETROFIT APPROACH USING MINIATURE TRANSDUCERS
STEPHEN A. JACKLIN (NASA, Ames Research Center, Moffett Field, CA), RAY MORT, and DWAYNE MORRISON (Bell Helicopter Textron, Inc., Fort Worth, TX) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 12 p. refs
(AIAA PAPER 92-0268) Copyright

This paper reports an approach used to retrofit a set of full-scale main rotor blades with 290 miniature pressure transducers, 46 strain gages, and 24 miniature accelerometers. Normally, in order to avoid disturbing the aerodynamics of the rotor flow field, the pressure instrumentation must be integrally built into the body of the rotor blades. However, using a method developed with NASA, miniature pressure transducers are mounted to the blade exterior surface without degrading the quality of the blade aerodynamics. Moreover, it is estimated that this approach reduced costs by more than 50 percent over building a set of pressure instrumented blades. The aerodynamic measurement objectives are presented as are instrumentation design considerations, type of instrumentation used, assembly process, and the installed instrumentation characteristics. Author

A92-25745*# National Aeronautics and Space Administration, Washington, DC.
EXPERIMENTAL EVALUATION OF CANDIDATE GRAPHICAL MICROBURST ALERT DISPLAYS
CRAIG WANKE and R. J. HANSMAN, JR. (MIT, Cambridge, MA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 11 p. Research supported by MIT and FAA. refs
(Contract NGL-22-009-640)
(AIAA PAPER 92-0292) Copyright

A piloted flight simulator experiment has been conducted to evaluate issues related to the display of microburst alerts on electronic cockpit instrumentation. Issues addressed include display clarity, usefulness of multilevel microburst intensity information, and whether information from multiple sensors should be presented separately or 'fused' into combined alerts. Nine active airline pilots of 'glass-cockpit' aircraft participated in the study. Microburst alerts presented on a moving map display were found to be visually clear and useful to pilots. Also, multilevel intensity information coded by colors or patterns was found to be important for decision-making purposes. Inconclusive results were obtained on whether to 'fuse' data from multiple sensors. The positional information included in the graphical alert presentation was found useful by the pilots for planning lateral missed-approach maneuvers, but may result in deviations which could interfere with normal airport operations. Author

A92-25746*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
ATMOSPHERIC ANALYSIS FOR AIRDATA CALIBRATION ON RESEARCH AIRCRAFT
L. J. EHERNBERGER, EDWARD A. HAERING, JR. (NASA, Flight Research Center, Edwards, CA), MARY G. LOCKHART, and EDWARD H. TEETS (PRC, Inc., Edwards, CA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 24 p. refs
(AIAA PAPER 92-0293) Copyright

In-flight airdata calibrations are used to determine the aerodynamic influence of an airplane on pitot-static pressure measurements of altitude and speed. Conventional flight-test calibration techniques are briefly reviewed and meteorological analysis methods for estimating calibration reference values of atmospheric conditions are described. There are cases where some conventional in-flight techniques are not entirely satisfactory for research aircraft because of added equipment requirements or flight envelope and location limitations. In these cases, atmospheric wind and pressure information can be used to complement conventional techniques. Accuracy of the atmospheric measurements and the variability of upper-air winds and pressure values are discussed. Results from several flight research aircraft show that wind reference calibration is generally less accurate than calibration accuracy standards for civil and research aircraft. Examples of pressure reference altimetry derived from meteorological analyses are also presented for a variety of flight research programs. These flight data show that the reference pressure accuracy provided by meteorological analyses is usually within civil aircraft and flight research airdata calibration accuracy standards. Meteorological analyses altimetry is particularly useful when it is not feasible to restrict the test airplane altitude, location, or maneuver envelope. Author

A92-25752#
DEVELOPMENT OF A SENSOR FOR THE DETECTION OF AIRCRAFT WING CONTAMINANTS
STUART INKPEN, CHRIS BROBECK, and CHRIS NOLAN (INSTRUMAR, Ltd., St. John's, Canada) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 7 p. Research supported by Transport Canada, DND, and National Research Council of Canada. refs
(AIAA PAPER 92-0300) Copyright

The design procedure of a sensor for the detection of aircraft wing contaminants is described. The sensor is capable of thickness measurement and discrimination between ice, water, their combinations, and deicing and antiicing fluids. The sensor design is based on the clean wing philosophy for critical surfaces of an aircraft and focuses on the identification of aircraft surface contamination before take-off. An operational prototype is tested by subjecting it to a range of environmental conditions involving a matrix of atmospheric conditions and deicing and antiicing fluids. Preliminary test results indicate that the sensor is highly sensitive and capable of distinguishing between subtle changes of ice/water mixtures and of measuring snow. O.G.

A92-25753#
LABORATORY EVALUATION OF A SENSOR FOR DETECTION OF AIRCRAFT WING CONTAMINANTS
M. M. OLESKIW (National Research Council of Canada, Ottawa) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 10 p. refs
(AIAA PAPER 92-0301) Copyright

A brief review of icing problems in aircraft is presented and

the development and testing of a sensor system to detect snow or ice on an aircraft prior to takeoff are described. The sensor performs its contaminant discrimination by evaluating the complex measurements it makes of the contaminants on its surface. The sensor demonstrated its ability to detect the transition between water, deicing fluids, antiicing fluids, and the beginning of ice formation on the sensor. R.E.P.

A92-27776
FIBER-COUPLED POSITION SENSORS FOR AEROSPACE APPLICATIONS
R. W. HUGGINS, G. L. ABBAS, C. S. HONG, G. E. MILLER, C. R. PORTER, and B. VAN DEVENTER (Boeing High Technology Center, Seattle, WA) Optics and Lasers in Engineering (ISSN 0143-8166), vol. 16, no. 2-3, 1992, p. 79-103. refs
Copyright

Fiber-coupled position sensors promise advantages over their electrical counterparts for aerospace applications such as weight savings, immunity to radiated electrical interference, and improved performance, but so far, no sensor has gained widespread acceptance. This paper describes three fiber-coupled sensors presently under development at the Boeing High Technology Center including a single track analog sensor, a sensor based on weighted number system encoding, and a sensor based on FMCW laser radar techniques. Technical difficulties encountered, customer requirements, and a summary of a standardized WDM sensor interface including a broadband LED source and a compact spectrograph are also discussed. Author

A92-27777
OPTICALLY POWERED AND INTERROGATED ROTARY POSITION SENSOR FOR AIRCRAFT ENGINE CONTROL APPLICATIONS
W. B. SPILLMAN, JR., D. H. CROWNE (BFGoodrich Aerospace, Vergennes, VT), and D. W. WOODWARD (Cornell University, Ithaca, NY) Optics and Lasers in Engineering (ISSN 0143-8166), vol. 16, no. 2-3, 1992, p. 105-118. refs
Copyright

A throttle level angle (TLA) sensing system is described that utilizes a capacitance based rotary position transducer that is powered and interrogated via light from a single multimode optical fiber. The system incorporates a unique GaAs device that serves as both a power converter and optical data transmitter. Design considerations are discussed, and the fabrication and performance of the sensor system are detailed. Author

A92-27785
COHERENCE MULTIPLEXED POLARIMETRIC FIBRE SENSOR ARRAYS FOR AEROSPACE APPLICATIONS
R. M. TAYLOR and M. J. RANSHAW (Smiths Industries Aerospace and Defence Systems, Ltd., Research and Product Technology Dept., Cheltenham, England) Optics and Lasers in Engineering (ISSN 0143-8166), vol. 16, no. 2-3, 1992, p. 223-236. Research supported by CEC. refs
Copyright

An efficient sensor array capable of supporting a number of sensors for different measurands and based on a common demultiplexing scheme is discussed. The application of a short coherence length signal processing scheme to a range of polarimetric type sensors, especially to an accelerometer design is described. It is noted that the choice of a multiplexing technique must be considered in conjunction with the network and aerospace requirements. O.G.

A92-27832
FAILURE DETECTION AND IDENTIFICATION FOR AIRCRAFT SENSORS
HONGYUE ZHANG (Beijing University of Aeronautics and Astronautics, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, Oct. 1991, p. B494-B502. In Chinese. refs

In order to improve aircraft-sensor system reliability, it is necessary to detect and identify the faulty sensor and reconstruct the signal measured by the sensor in real time. Hardware and analytical redundancy are adopted for this purpose. A comprehensive survey is given regarding the analytical redundancy technology. Numerous schemes of analytical redundancy for aircraft sensors are introduced. The principle of statistical decision-making for analytical redundancy and the robustness of failure-detection and identification algorithms are discussed briefly. Author

A92-27837
A NEW METHOD FOR ORIENTATION CALCULATION OF THE ELECTROMAGNETIC HELMET-MOUNTED SIGHTING UNIT
SHUXIAN SONG, BENQING GAO, and CIPING DENG (Beijing Polytechnical University, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, Oct. 1991, p. B518-B522. In Chinese. refs

A new method for orientation calculation based on practical studies is proposed. This method is succinct in forms and offers key advantages in processing-speed, memory-consuming, and error-correction over other methods used in the same kind of systems of EHMSU abroad. The cardinal principles and calculation formulas of the new method are presented, and the experimental results for verifying it are discussed. Author

A92-27906
PRECISION ANALYSIS ON STATIC MEASUREMENT OF RADAR CROSS SECTION
MINGGUI ZHAO, TAO HUANG, and WEIMIN SHI (Research Institute of Pilotless Aircraft, People's Republic of China) Nanjing Aeronautical Institute, Journal (ISSN 1000-1956), vol. 24, Feb. 1992, p. 54-62. In Chinese. refs

Some factors which have great effect on the measurement precision of RCS in anechoic chambers, including the noise of background, the coupling between transmitting and receiving antennas and the choice of the standardized objects are discussed. The conclusion that the main measurement errors come from the standardized objects and the support is presented. Finally, two principles are given in order to meet the needs of measurement precision: (1) the RCS of the targets must be 20 dB above that of the background; (2) the support and the standardized objects should be selected according to the RCS level of the target. By means of these principles, a 200 mm x 200 mm metal plate is used for comparing its theoretical and measured data. Very good results are obtained that verify the correctness of the principles. Author

N92-18014# Aeronautical Systems Div., Wright-Patterson AFB, OH.
AN EVALUATION OF FOUR F-16 VERTICAL VELOCITY INDICATOR CONFIGURATIONS Final Report, Feb. - May 1990
SCOTT M. CONE and JOHN A. HASSOUN Nov. 1991 53 p
(AD-A243629; ASD-TR-91-5007) Avail: NTIS HC/MF A04
CSCL 14/2

Four different Vertical Velocity Indicator (VVI) configurations/mechanizations were evaluated in an F-16C simulator: (1) F-16C moving tape VVI; (2) electromechanical semicircular, moving pointer VVI; (3) liquid crystal, semicircular, moving pointer VVI; and (4) same as 3 with a faster response time. Configurations 1, 2, and 3 had the same dampening characteristics as are currently used in the F-16C; configuration 4 was included to assess the impact of VVI dampening on pilot performance. Ten pilots flew a series of rate climbs/descents and an Instrument Landing System approach and landing for each configuration. Pilot performance data showed a larger average pitch rate for the moving tape VVI, suggesting greater workload, and an improved ability to maintain a specified vertical velocity when using configuration 4. Subjective data showed that the moving tape was the least preferred of the four, especially for use in dynamic conditions. GRA

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AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and on-board auxiliary power plants for aircraft.

A92-24403* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
HOT GAS ENVIRONMENT AROUND STOVL AIRCRAFT IN GROUND PROXIMITY. II - NUMERICAL STUDY
D. K. TAFTI and S. P. VANKA (Illinois, University, Urbana) Journal of Aircraft (ISSN 0021-8669), vol. 29, Jan.-Feb. 1992, p. 20-27. Previously cited in issue 19, p. 2984, Accession no. A90-42766. refs
(Contract NAG3-1026)
Copyright

A92-24409
HOT GAS ENVIRONMENT AROUND STOVL AIRCRAFT IN GROUND PROXIMITY. I - EXPERIMENTAL STUDY
R. MACLEAN, J. SULLIVAN, and S. N. B. MURTHY (Purdue University, West Lafayette, IN) Journal of Aircraft (ISSN 0021-8669), vol. 29, Jan.-Feb. 1992, p. 67-72. Previously cited in issue 19, p. 2984, Accession no. A90-42765. refs
Copyright

A92-24738
NUMERICAL MODELLING FOR GAS DUCT IN TUBOANNULAR COMBUSTOR
CHANGLIN LI, JIXIAN YAO, and WEI LIU (Northwestern Polytechnical University, Xian, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, Jan. 1992, p. 43-46. In Chinese.

A numerical approach to modeling of hot-gas duct in a tuboannular combustor is suggested. The modeling scheme is based on five controlling rules: top and bottom curves on central profile, radii of top and bottom arcs of cross sections, and area of cross sections. A three-dimensional hot-gas duct is regarded as a stacking of finite two-dimensional cross sections constrained by the rules. A brief analysis of computed rules is presented as well. As an example the hot-gas duct of the SPEY engine is computed by using this method. Comparison between the computed cross sections and real ones obtained from SPEY technical drawings shows that the method is effective and practicable. Author

A92-24739
STUDY ON RELIABILITY DESIGN OF TURBINE BLADE
JINYUAN SHI (Shanghai Power Equipment Research Institute, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, Jan. 1992, p. 47-50. In Chinese. refs

A reliability design method for fatigue strength of turbine blades is presented. The method uses static stresses, dynamic stresses, and the blade endurance strength as random variables. The scatter effects of the centrifugal tensile stress, the centrifugal bending stress, and the gas bending stress are taken into consideration when the distribution parameters of the static stresses are determined. The scatter effect of the static natural frequency, the dynamic natural frequency, the stimulus, and the amplification factor are considered and the distribution parameters of dynamic stresses are determined. The distribution parameters of the fatigue stress and the fatigue strength of the blades are obtained by the plotting method from the blade endurance strength graphs. The reliability of the blades can be estimated in the design stage by using interference modes for fatigue stress distribution and fatigue strength distribution. C.D.

A92-24740
EFFECT OF SOME LOAD FACTORS OF BIRD IMPACT ON BLADE RESPONSE
JING YIN (Nanjing Aeronautical Institute, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, Jan. 1992, p. 51-54. In Chinese. refs

The effect of some load factors of bird impact on blade response is analyzed in this paper. These factors include momentum transfer, load-duration, loading location, and spatial distribution of loads. The finite element method is used to compute the nonlinear transient response of the blade by means of simulating a real blade with a rectangular cantilever plate and simulating bird impact loads with shock loads. The local and total deflection of the blade are directly proportional to momentum transfer to the blade. The load-duration affects directly the deformation and stress states of the blade too. So the two parameters must be accurately predicted when a load model is developed. It is also very important to predict correctly the load location on the blade because the eccentric loads cause the greater deflection and twisting. The spatial distribution forms for distributed loads seem to have a little effect on blade response. Author

A92-24741
STRATEGIES FOR OPTIMAL DESIGN OF GAS TURBINE DISKS
DONGXU ZHANG, GENGDONG CHENG, YONGKONG SUI, LIMIN SHONG (Dalian University of Technology, People's Republic of China), XIANGSHENG LIU, and JUNYUE CHEN (Shenyang Aeroengine Research Institute, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, Jan. 1992, p. 55, 56. In Chinese. refs

A number of strategies for optimal design of the gas turbine disks are proposed, including separation of tenons design from disk design, rational simplification of structural model, check on local constraints, optimal design based on elastic analysis and further check based on elastoplastic analysis, and multilevel optimization by grouping design variables. Using the strategies, a computer program TDSOS is developed for practical use. By applying the strategies and the program TDSOS, shape optimization of gas turbine disk with light mass and low stress level can be obtained and the contradiction among high performance index, reliability, and long life expectation is better solved. Author

A92-24745
TRIPLE CONTRA-ROTATING TURBINE AND ITS BASIC ANALYSIS
RUIXIAN CAI (Chinese Academy of Sciences, Institute of Engineering Thermophysics, Beijing, People's Republic of China) and XINGLU WEI (Beijing University of Aeronautics and Astronautics, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, Jan. 1992, p. 72-76. In Chinese. refs

A comprehensive basic analysis for various triple contrarotating turbines is given with the blade element stage assumption. The appropriate independent variables and evaluation criteria of the triple contrarotating turbine stages are first presented by analogy with the classical analysis of conventional turbine stages. Then three typical kinds of rotating blade rows are defined and all possible typical schemes of such stages are enumerated. The characteristics of specific work and load distribution of the triple contrarotating shafts are presented in a very simple form. The typical triple contrarotating turbine stages suitable to the three shaft gas turbine power plants are analyzed and given. From the analysis results it is concluded that the load capacity per unit engine length of the triple contrarotating turbines can be much higher than that of conventional turbines. Author

A92-24746
OPTIMIZATION OF MULTISTAGE AXIAL-FLOW COMPRESSOR VANE SETTING
YONGMING WANG (Gas Turbine Establishment, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, Jan. 1992, p. 77-80. In Chinese. refs

A method has been developed for calculating optimum stage angles of vanes in the axial-flow compressor performance adjustment tests. The method uses a square Taylor series as an

approximate optimization model, determines initial vane angle changes in axial-flow compressor tests, and obtains directions and steps for vane adjustment. The method offers fast convergence and less iteration, and suitability for test data calculation and error measurement. Compared with existing methods, it reduces the periods and times of compressor performance tests. C.D.

A92-24750
A SIMPLIFIED METHOD OF TRANSIENT MATHEMATICAL MODEL FOR NON-AUGMENTATION ENGINE
WEIFENG YU and SHAOJI ZHANG (Shenyang Aeroengine Research Institute, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, Jan. 1992, p. 92-94. In Chinese.

A simplified method of transient mathematical model for nonaugmentation engine is presented, which is used in real-time simulation for developing engine control system. Two spool inertias are considered in the simplified model, which are the main factors for engine transient performance. The combination of engine steady characteristics with transient characteristics is used in the model. The simulation shows that the model has better accuracy and fast operating speed, has better flexibility and is easy to use in different engines, and is convenient for programming in C or FORTRAN language. Author

A92-24878
INFLUENCE OF AIR LIQUEFACTION CYCLE ON PERFORMANCE OF COMBINED CYCLE ENGINE
QINGXIONG ZHENG, XIAOCHUN LIAN, and CHEN FUQUN (Northwestern Polytechnical University, Xian, People's Republic of China) Northwestern Polytechnical University, Journal (ISSN 1000-2758), vol. 10, Jan. 1992, p. 14-20. In Chinese. refs

The effect of the air liquefaction cycle (LACE) on the performance of a supercharged ejector ramjet combined cycle engine is described. Through computer simulation it is determined that LACE enhances specific impulse but reduces thrust. Results show that engine performance with LACE without separation of air into oxygen and nitrogen is much improved over engine performance with air separation. R.E.P.

A92-25373
SINGLE LEVER POWER MANAGEMENT OF TURBOPROP ENGINES
Aerospace Engineering (ISSN 0736-2536), vol. 12, Feb. 1992, p. 23-27.
Copyright

The development of a single-lever power management system to reduce pilot workload required for power adjustment of a turboprop engine is described. This single-lever allows the control system to adjust engine power through fuel flow. Propeller speed is adjusted by a set of switches controlling all takeoff, climb, and cruise conditions. R.E.P.

A92-25696*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A NEW UNSTEADY MIXING MODEL TO PREDICT NO(X) PRODUCTION DURING RAPID MIXING IN A DUAL-STAGE COMBUSTOR
SURESH MENON (Quest Integrated, Inc., Kent, WA), PATRICK A. MCMURTRY (Utah, University, Salt Lake City), ALAN R. KERSTEIN (Sandia National Laboratories, Livermore, CA), and J.-Y. CHEN (California, University, Berkeley) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 13 p. Research supported by DOE and University of Utah. refs
(Contract NAS3-26242)
(AIAA PAPER 92-0233) Copyright

An advanced gas turbine engine to power supersonic transport aircraft is currently under study. In addition to high combustion efficiency requirements, environmental concerns have placed stringent restrictions on the pollutant emissions from these engines. A dual-stage combustor with the potential for minimizing pollutants such as NO(x) emissions is undergoing experimental evaluation. A major technical issue in the design of this combustor is how to rapidly mix the hot, fuel-rich primary stage product with the secondary diluent air to obtain a fuel-lean mixture for combustion in the secondary stage. Numerical design studies using steady-state methods cannot account for the unsteady phenomena in the mixing region. Therefore, to evaluate the effect of unsteady mixing and combustion processes, a novel unsteady mixing model is demonstrated here. This model has been used in a stand-alone mode to study mixing and combustion in hydrogen-air nonpremixed jet flames. NO(x) production in these jet flames was also predicted. Comparison of the computed results with experimental data show good agreement thereby providing validation of the mixing model. Author

A92-26234*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
UNSTEADY BLADE PRESSURES ON A PROPFAN AT TAKEOFF - EULER ANALYSIS AND FLIGHT DATA
M. NALLASAMY (Sverdrup Technology, Inc., Brook Park, OH) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 11 p. Previously announced in STAR as N92-13071. refs
(Contract NAS3-25266)
(AIAA PAPER 92-0376)

The unsteady blade pressures due to the operation of the propfan at an angle to the direction of the mean flow are obtained by solving the unsteady three dimensional Euler equations. The configurations considered is the eight bladed SR7L propfan at takeoff conditions and the inflow angles considered are 6.3 deg, 8.3 deg, 11.3 deg. The predicted blade pressure waveforms are compared with inflight measurements. At the inboard radial station ($r/R = 0.68$) the phase of the predicted waveforms show reasonable agreement with the measurements while the amplitudes are over predicted in the leading edge region of the blade. At the outboard radial station ($r/R = 0.95$), the predicted amplitudes of the waveforms on the pressure surface are in good agreement with flight data for all inflow angles. The measured (installed propfan) waveforms show a relative phase lag compared to the computed (propfan alone) waveforms. The phase lag depends on the axial location of the transducer and the surface of the blade. On the suction surface, in addition to the relative phase lag, the measurements show distortion (widening and steepening) of the waveforms. The extend of distortion increases with increase in inflow angle. This distortion seems to be due to viscous separation effects which depend on the azimuthal location of the blade and the axial location of the transducer. Author

A92-26247#
TWO AND THREE DIMENSIONAL PARABOLIZED NAVIER-STOKES CODE FOR SCRAMJET COMBUSTOR, NOZZLE, AND FILM COOLING ANALYSIS
HOUSHANG B. EBRAHIMI and MIKE GILBERTSON (Rockwell International Corp., Downey, CA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 11 p. refs
(AIAA PAPER 92-0391) Copyright

Accurate prediction of combustor and nozzle flows for scramjets is important for design and system performance analysis. Scramjet combustor and nozzle flow fields are quite complex due to the presence of strong non-uniform entrance profiles, turbulent mixing and chemical reactions. Rapid chemical reactions in combustors and expansion processes common in nozzles imply substantial radial pressure gradients. To meet these requirements, two and three-dimensional parabolized Navier-Stokes codes have been developed for parametric studies of hypersonic combustor, nozzle and plume flows. This paper focuses on the two-dimensional capabilities and applications of the code. The LEPNS code utilized a general hydrogen chemistry model, MacCormack of Beam and Warmings implicit algorithm for integrating partial differential equations, and either the K-Epsilon or Bushnell eddy viscosity turbulence model. The present numerical solutions were validated using the available experimental data and other numerical results. Author

A92-26252#
TURBINE DISK TEMPERATURES RESULTING FROM THE HOT MAINSTREAM AT ENGINE CONDITIONS
S. H. KO and D. L. RHODE (Texas A & M University, College Station) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 9 p. Research supported by Texas A & M University. refs
(AIAA PAPER 92-0398) Copyright

The complete momentum and thermal interaction between the hot turbine mainstream and the cooler disk cavity and rim seal region was examined using solutions from an advanced finite volume computer code. The elliptic, axisymmetric, time-averaged Navier-Stokes equations were solved along with turbulence equations for a recently tested multi-scale k-e model. Realistic engine temperatures, pressures and flow rates were utilized for the mainstream and cavity purge flow. Baseline axisymmetric solutions for a generalized configuration provides first-order characteristics of the disk temperature rise due to the thermal transport via a small rim seal (gap) recirculation zone and via disk frictional heating. A very abrupt disk surface temperature rise is found near the turbine blade retainer/root at the radial location where the cavity purge Ekman layer meets the opposing gap recirculation zone. Author

A92-26253*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
DESIGN OF A HYBRID LAMINAR FLOW CONTROL NACELLE
YONG-SUN WIE (High Technology Corp., Hampton, VA), FAYETTE S. COLLIER, JR., RICHARD D. WAGNER (NASA, Langley Research Center, Hampton, VA), JEFFERY K. VIKEN, and WERNER PFENNINGER (Analytical Services and Materials, Inc., Hampton, VA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 14 p. refs
(AIAA PAPER 92-0400) Copyright

Consideration is given to the potential application of hybrid-laminar-flow control to the external surface of a modern, high-bypass-ratio (HBR) turbofan engine nacelle. With the advent of advanced ultra-HBR fans (with bypass ratios of 10-15), the wetted areas of these nacelles approach 10 percent of the total wetted area of future commercial transports. A hybrid-laminar-flow-control pressure distribution is specified and the corresponding nacelle geometry is computed utilizing a predictor/corrector design method. Linear stability calculations are conducted to provide predictions of the extent of the laminar boundary layer. Performance studies on an advanced twin-engine transport configuration are presented to determine potential benefits in terms of reduced fuel consumption. Author

A92-26376
CARS TEMPERATURE MEASUREMENTS AND VALIDATION OF A COMPUTING CODE ON A GAS-TURBINE COMBUSTOR [MESURES DE TEMPERATURE PAR DRASC ET VALIDATION D'UN CODE DE CALCUL SUR FOYER DE TURBOREACTEUR]
P. MAGRE, G. COLLIN (ONERA, Chatillon, France), D. ANSART, C. BAUDOUIN, and Y. BOUCHIE (SNECMA, Centre d'Essais de Villaroche, Moissy-Cramayel, France) (European Propulsion Forum 91, Paris, France, Nov. 13-15, 1991) ONERA, TP no. 1991-224, 1991, 15 p. In French. Research supported by EURAM. refs
(ONERA, TP NO. 1991-224)

The paper describes tests carried out within the framework of the European Low Emission Combustor Technology project, whose aim was to evaluate the potential of future combustor technologies for the reduction of pollution levels. First, ONERA applied CARS to obtain temperature profiles in the interiors and outlets of representative gas-turbine combustors. SNECMA then compared the results obtained with those obtained from classical test techniques for the qualification of combustor outlet conditions. In addition, measurements performed in the chamber interiors were used to validate the SNECMA computing code (3D, finite volumes, the SIMPLE algorithm) which guides the development of combustor chambers. L.M.

A92-26920
CONCERNING A BASIC ASSUMPTION FOR AEROELASTICITY IN TURBOMACHINERY
XIAO-DONG YANG, DE-PING TAO, and SHENG ZHOU (Beijing University of Aeronautics and Astronautics, People's Republic of China) Science in China, Series A - Mathematics, Physics, Astronomy and Technological Sciences (ISSN 1001-6511), vol. 34, June 1991, p. 746-754. refs
Copyright

One of the basic assumptions for aeroelasticity in turbomachinery that the interblade phase angle along a blade row is constant has been proved to be invalid by the fact that neither dynamic stresses nor interblade phase angles are constant along a blade row when the stall flutter occurs. With this assumption abandoned, a new model and the corresponding numerical method have been developed. Comparisons between calculations and measurements showed that the main cause which makes blade dynamic stresses unequal along a blade row in the unstable aeroelastic process is inequable interblade phase angle distribution along the blade row. Author

A92-26940#
THERMAL MANAGEMENT OF AIR-BREATHING PROPULSION SYSTEMS
JOHN E. AHERN AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 12 p. refs
(AIAA PAPER 92-0514) Copyright

A first- and second-law exergy analysis technique is presented that yields data suitable for application to the integrated evaluation of heat sources and sinks in an aircraft. The system integration is based on the design of effective heat exchange between specific subsystems and on the development of maximum cooling capacity for the fuel. The cooling and power-supply subsystems are identified as components which can be supported by the cooling of the engine and by aerodynamically heated surfaces. The engine fuel flow can be used to heat-sink the subsystems, and some heat-exchanger designs are described. The heat-sink capacity of the fuel supply can be enhanced through the use of endothermic catalytic conversions of hydrogen and hydrocarbon fuels. The present thermal management methodology is of interest to the study and optimization of air-breathing propulsion systems for high-speed flight. C.C.S.

A92-26941#
THERMAL MANAGEMENT SYSTEMS FOR HIGH MACH AIRBREATHING PROPULSION
ROBERT F. BERGHOLZ and BRADLEY D. HITCH (GE Aircraft Engines, Cincinnati, OH) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 25 p. refs
(AIAA PAPER 92-0515) Copyright

The paper focuses on the unique technical problems encountered in the design and analysis of an integrated thermal management system (TMS) for high-Mach airbreathing propulsion engines. A generic turboramjet cycle designed for a cruise mission in the Mach 4-6 regime is used to illustrate the engine aerothermal conditions and TMS architecture and operating requirements. Author

A92-26942#
THERMAL MANAGEMENT OF PROPULSION SYSTEMS IN HYPERSONIC VEHICLES
K. RUED, G. EBENHOCH, and H. MARK (MTU Motoren- und Turbinen-Union Muenchen GmbH, Munich, Federal Republic of Germany) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 10 p. Research supported by BMFT. refs
(AIAA PAPER 92-0516) Copyright

This paper addresses the salient features of thermal management and component cooling concepts for hydrogen fueled turbo-ramjet propulsion systems in hypersonic vehicles. The results were obtained from basic feasibility studies on engine design and from supporting technology readiness programs. The data presented herein cover flight speeds up to approximately Mach 6;

they focus on the assessment of the overall cooling requirements, on the thermal and structural design of actively cooled engine structures and on the evaluation of most suitable heat exchanger systems for generating cooling air and other coolants. A heat balance compares the total cooling requirements with the available heat sink capacity of the hydrogen fuel flow. Author

A92-27007*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A SYSTEMATIC EXPERIMENTAL AND COMPUTATIONAL INVESTIGATION OF A CLASS OF CONTOURED WALL FUEL INJECTORS
IAN A. WAITZ, FRANK E. MARBLE, and EDWARD E. ZUKOSKI (California Institute of Technology, Pasadena) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 22 p. refs
(Contract NAG1-842; F49620-86-C-0113)
(AIAA PAPER 92-0625) Copyright

The performance of contoured wall fuel injectors for scramjet engine applications is considered. These fuel injectors were aimed at augmenting mixing through axial vorticity production arising from interaction of the fuel/air interface with an oblique shock. The effects of incoming boundary layer height, injector spacing, and injectant to freestream pressure and velocity ratios are examined. Results from 3D flow field surveys and Navier-Stokes simulations are presented. R.E.P.

A92-27108#
A NUMERICAL METHOD FOR SIMULATING THE FLUID-DYNAMIC AND HEAT-TRANSFER CHANGES IN A JET ENGINE INJECTOR FEED-ARM DUE TO FOULING
V. R. KATTA (Systems Research Laboratories, Inc., Dayton, OH) and W. M. ROQUEMORE (USAF, Wright Laboratory, Wright-Patterson AFB, OH) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 13 p. refs
(Contract F33615-90-C-2033)
(AIAA PAPER 92-0768)

A computational method for integrating the fluid-dynamic calculations and the heat-transfer calculations in different segments of solid boundaries is developed to predict deposition inside tubes. The fuel thermal-degradation mechanism is treated mathematically using a three-step global chemistry model. Deposits are allowed to grow on the wall surface, and the resulting fluid-dynamic and heat-transfer changes are implicitly computed using a time-dependent formulation. Turbulent flow simulations for the fuel flow bounded by the fuel-deposit interface are made on a body-oriented coordinate system. Induction period, associated with the slower deposition during the initial hours of exposure, is modeled by introducing a wall reaction-type mechanism for the surface sticking phenomenon. Calculations are made for the full-scale and half-scale gas-turbine injector feed-arm rigs. Temperature at the deposit-tube interface increased with deposition. Results in the form of accumulated deposit weight and the changes in the tube inner wall temperature with time are compared with the experimental data. Effects of fouling on heat transfer and blockage to the fuel flow are discussed. Author

A92-27114#
A NUMERICAL STUDY OF SECONDARY FUEL INJECTION TECHNIQUES FOR ACTIVE CONTROL OF COMBUSTION INSTABILITY IN A RAMJET
SURESH MENON (Quest Integrated, Inc., Kent, WA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 17 p. refs
(Contract N00014-90-C-0089)
(AIAA PAPER 92-0777) Copyright

Combustion instability in a ramjet combustor has been numerically simulated using a large-eddy simulation technique. Premixed combustion in the combustor is simulated using a thin-flame model that explicitly determines the turbulent flame speed as a function of the laminar flame speed and subgrid turbulent kinetic energy. Two different inlet duct length, a short inlet and a long inlet configurations were modeled. Low frequency, large amplitude pressure oscillations characteristic of combustion instability is simulated in both configurations. Active control using secondary fuel injection upstream of the flame holder employing different types of control algorithms have been investigated. Results show that control of the instability can be successfully achieved in some cases, while in other cases, the control algorithm is only partially effective. Author

A92-27354
COMBUSTION INSTABILITY RELATED TO VORTEX SHEDDING IN DUMP COMBUSTORS AND THEIR PASSIVE CONTROL
K. C. SCHADOW and E. GUTMARK (U.S. Navy, Naval Weapons Center, China Lake, CA) Progress in Energy and Combustion Science (ISSN 0360-1285), vol. 18, no. 2, 1992, p. 117-132. refs
Copyright

This review summarizes recent research program related to the driving mechanism of dump combustor instability. Its scope includes experimental research in dump combustors using gaseous fuel. The emphasis here is on vortex shedding as a driving mechanism of combustion instabilities. It is shown that the development of coherent flow structures and their breakdown into fine-scale turbulence can lead to periodic heat release, which, when in phase with the pressure oscillation, can drive the oscillations as stated by the Rayleigh criterion. The physical processes associated with the vortex breakdown are described. This understanding is used to passively control and reduce the pressure oscillations, as demonstrated for dump and bluff body stabilized combustion flows. Author

A92-27857
INTEGRAL MINIMIZATION OF ENGINE FAULT EQUATIONS BASED ON LEAST FAULT PRINCIPLE
ZUOMIN FAN, CHUNLIN SUN, and ZHAOFU LIN (Civil Aviation Institute of China, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, Sept. 1991, p. A482-A487. In Chinese. refs

The fault diagnosis problem involves resolving a limited set of measurements in terms of a large set of possible but improbable malfunctions. The least fault principle can be used to solve the underdetermined equations using two methods: the integral minimization approach and the combination minimization approach. The two methods of constrained integral minimization based on the least fault principle are presented here. A practical example of engine fault diagnosis is given and the methods are evaluated. C.D.

A92-27913
EFFECT OF DIFFERENT FORCE-FUNCTIONS AND INITIAL SHOCK PRESSURE ON BLADE RESPONSE
JING YIN and QINGHONG LI (Nanjing Aeronautical Institute, People's Republic of China) Nanjing Aeronautical Institute, Journal (ISSN 1000-1956), vol. 24, Feb. 1992, p. 107-111. In Chinese. refs

The effect of two kinds of load factors of bird impact on blade response is analyzed. They are the force functions and the initial shock pressure. The FEM is used to compute the nonlinear transient response of the cantilever plate by means of simulating a real blade with a rectangular cantilever plate and simulating bird impact loads with shock loads. The conclusions obtained may provide references for the development of a bird impact load model. Author

A92-28191*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
CALCULATIONS OF HOT GAS INGESTION FOR A STOVL AIRCRAFT MODEL
D. M. FRICKER (NASA, Lewis Research Center; U.S. Army, Propulsion Directorate, Cleveland, OH), J. D. HOLDEMAN (NASA, Lewis Research Center, Cleveland, OH), and S. P. VANKA (Illinois, University, Urbana) AIAA, Aerospace Sciences Meeting and

Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 10 p. refs
(AIAA PAPER 92-0385)

Hot gas ingestion problems for STOVL (Short Take-Off, Vertical Landing) aircraft are typically approached with empirical methods and experience. In this study, the hot gas environment around a STOVL aircraft was modeled as multiple jets in crossflow with inlet suction. The flow field was calculated with a Navier-Stokes, Reynolds-averaged, turbulent, 3D CFD code using a multigrid technique. A simple model of a STOVL aircraft with four choked jets at 1000 K was studied at various heights, headwind speeds, and thrust splay angles in a modest parametric study. Scientific visualization of the computed flow field shows a pair of vortices in front of the inlet. This and other qualitative aspects of the flow field agree well with experimental data. Author

A92-28419
NUMERICAL SIMULATION OF TWO INCOMING STREAMS IN A DUAL-COMBUSTION RAMJET COMBUSTOR
JIHUA MA and JIAXI DIN (Beijing University of Aeronautics and Astronautics, People's Republic of China) Journal of Propulsion Technology (ISSN 1001-4055), June 1991, p. 54-61. In Chinese.

A physicomathematical model for the incoming flow in a dual combustion ramjet combustor is developed. Special attention is given to the combustor design and to the method for solving the flow field using Euler equations. The preliminary results of computations are discussed. I.S.

A92-28434
AN INVESTIGATION ON THE CHARACTERISTICS OF COMBUSTOR WITH OBLIQUE AIR JET
QINGFAN ZHANG, PING XI, QIANG ZHONG, and XIAOMEI ZHANG (Nanjing Aeronautical Institute, People's Republic of China) Journal of Propulsion Technology (ISSN 1001-4055), Aug. 1991, p. 57-60. In Chinese.

An experimental investigation is conducted of an obliquely angled air jet on the combustion efficiency, lean-fuel limit and temperature profile of a combustor exit; data were also obtained for a combustor with an axisymmetric air jet, in order to make suitable comparisons. The results obtained indicate that the lean-fuel limit and combustion efficiency are improved for the oblique-air jet case; this improvement is found to be maximized in the case of a 15-deg obliqueness, rather than a 10-deg obliqueness. O.C.

A92-28435
AN INVESTIGATION ON FLAME STABILITY BY FUEL PERMEABILITY IN A FLAME HOLDER MADE OF POROUS CERAMIC MATERIAL
SHENGTONG DU, HUIXIAN SUN, MING TANG, and BINGLU CHEN (Northwestern Polytechnical University, Xian, People's Republic of China) Journal of Propulsion Technology (ISSN 1001-4055), Aug. 1991, p. 61-67. In Chinese. refs

An investigation is made of the characteristics and comparative advantages of combustion that is sustained by fuel permeability in a porous ceramic flameholder. The results obtained suggest advantageous application of such porous ceramics in several gas turbine combustor components. The range of flammability is noted to widen, due to the vaporization and continuous permeability of the fuel. O.C.

A92-28436
EXPERIMENTAL INVESTIGATION ON THE STRUCTURE OF FLOW FIELD AND THE TOTAL PRESSURE LOSS IN AN ATOMIZING CHANNEL INJECTOR
YEPING FAN and JIAHUA WANG (Nanjing Aeronautical Institute, People's Republic of China) Journal of Propulsion Technology (ISSN 1001-4055), Aug. 1991, p. 68-72. In Chinese. refs

An experimental investigation is conducted of the flow field and total pressure loss in an atomizing channel injector. The results obtained indicate that the total pressure loss increased with channel widening, flow velocity, and distance from channel to fuel rod. It is in addition noted that the total pressure-loss difference between an atomizing channel injector and a single cylinder rod is comparatively small, under operating conditions representative of an afterburner. O.C.

A92-28459
SURGE-TROUBLESHOOTING OF A TWIN-SPOOL TURBOJET ENGINE TESTED AT A HIGH ALTITUDE TEST FACILITY
QING ZHU (31st Research Institute, People's Republic of China) Journal of Propulsion Technology (ISSN 1001-4055), Oct. 1991, p. 51-57, 76. In Chinese. refs

Results are presented from surge troubleshooting tests of a twin-spool turbojet engine, performed at a high-altitude test facility, with special attention given to the effect of the inlet-flowfield distortion on the stability of a twin-spool turbojet. An FFT signal processor was used for the signal analysis and the diagnosis of the surge. Results of the tests indicate that most of the surge in a turbojet compressor under turbulent dynamic inlet distortion conditions is of a 'drift-mode' type, occurring at random. The turbojet was far more sensitive to a dynamic inlet distortion than to a steady inlet distortion. I.S.

A92-28479
AN IMPROVED COMPUTATION FOR GAS-TURBINE COMBUSTION CHAMBER FLOW
HONGZHE CHANG and HESONG HU (Shanghai Jiaotong University, People's Republic of China) Journal of Propulsion Technology (ISSN 1001-4055), Feb. 1992, p. 19-25. In Chinese. refs

Considering the effect of streamline curvature and the nonisotropism of turbulence, a wall function was taken into account in the numerical computation. The results agreed with the experimental data quite well. Therefore, it was necessary to consider the above mentioned effect in future studies of gas-turbine combustion chamber flow. Author

A92-28480
CALCULATION OF COMBUSTION EFFICIENCY OF DUMP COMBUSTOR IN RAMJET ENGINE
SHAOQING WANG (31st Research Institute, People's Republic of China) Journal of Propulsion Technology (ISSN 1001-4055), Feb. 1992, p. 26-31. In Chinese. refs

Calculation of the combustion efficiency of dump combustors in ramjet engine is discussed. The parameters discussed include inflow angle, the location of fuel manifold, the equivalence ratio, and the combustor pressure. The original combustion efficiency parameter considered by Lefebvre and Gordon is modified. A new combustion efficiency parameter Omega is presented, and a quantitative relation between combustion efficiency and Omega is formulated. The combustion efficiency was calculated by using the new formula. The deviation of calculated data from experimental data is within the range of 5-10 percent. The calculated method can also be used to the conventional ramjet engine. Author

A92-28517
STRUCTURAL AND AERODYNAMIC ANALYSIS OF A LARGE-SCALE ADVANCED PROPELLER BLADE
O. YAMAMOTO and R. AUGUST (Sverdrup Technology, Inc., Brook Park, OH) Journal of Propulsion and Power (ISSN 0748-4658), vol. 8, Mar.-Apr. 1992, p. 367-373. Previously cited in issue 19, p. 2985, Accession no. A90-42793. refs

A92-28531
LASER-INITIATED CONICAL DETONATION WAVE FOR SUPERSONIC COMBUSTION
G. CARRIER, F. FENDELL, R. MCGREGOR, S. COOK, and M. VAZIRANI (TRW Space and Technology Group, Redondo Beach, CA) Journal of Propulsion and Power (ISSN 0748-4658), vol. 8, Mar.-Apr. 1992, p. 472-480. Previously cited in issue 06, p. 809, Accession no. A91-19368. refs
(Contract F49620-87-C-0081)
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A92-28533* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EVALUATION OF PARALLEL INJECTOR CONFIGURATIONS FOR MACH 2 COMBUSTION
G. B. NORTHAM (NASA, Langley Research Center, Hampton, VA), I. GREENBERG, C. S. BYINGTON (George Washington University, Hampton, VA), and D. P. CAPRIOTTI (Analytical Services and Materials, Hampton, VA) Journal of Propulsion and Power (ISSN 0748-4658), vol. 8, Mar.-Apr. 1992, p. 491-499. Previously cited in issue 20, p. 3092, Accession no. A89-46898. refs
Copyright

A92-28534* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
COMPUTATIONS OF MULTISPECIES MIXING BETWEEN SCRAMJET NOZZLE FLOW AND HYPERSONIC FREESTREAM
OKTAY BAYSAL, MOHAMED E. ELESHAKY, and WALTER C. ENGELUND (Old Dominion University, Norfolk, VA) Journal of Propulsion and Power (ISSN 0748-4658), vol. 8, Mar.-Apr. 1992, p. 500-506. Previously cited in issue 09, p. 1292, Accession no. A89-25005. refs
(Contract NAG1-811)
Copyright

A92-28535* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
HYDROCARBON-FUELED SCRAMJET COMBUSTOR INVESTIGATION
I. W. KAY, W. T. PESCHKE, and R. N. GUILE (United Technologies Research Center, East Hartford, CT) Journal of Propulsion and Power (ISSN 0748-4658), vol. 8, Mar.-Apr. 1992, p. 507-512. Previously cited in issue 17, p. 2651, Accession no. A90-40622. refs
(Contract NAS1-17794)
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A92-28536
SUPERSONIC NOZZLE MIXER EJECTOR
T. G. TILLMAN, R. W. PATERSON (United Technologies Research Center, East Hartford, CT), and W. M. PRESZ, JR. (Western New England College, Springfield, MA) Journal of Propulsion and Power (ISSN 0748-4658), vol. 8, Mar.-Apr. 1992, p. 513-519. Research sponsored by United Technologies Corp. Previously cited in issue 20, p. 3095, Accession no. A89-47178. refs
Copyright

A92-28538* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
FLOW IN A VENTRAL NOZZLE FOR SHORT TAKEOFF AND VERTICAL LANDING AIRCRAFT
CRAWFORD F. SMITH (NASA, Lewis Research Center, Cleveland; Sverdrup Technology, Inc., Brook Park, OH) and JACK G. MCARDLE (NASA, Lewis Research Center, Cleveland, OH) Journal of Propulsion and Power (ISSN 0748-4658), vol. 8, Mar.-Apr. 1992, p. 530-536. Previously cited in issue 19, p. 2982, Accession no. A90-42688. refs
(Contract NAS3-25266)
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N92-18230# Oak Ridge National Lab., TN.
FIBER-SENSOR DESIGN FOR TURBINE ENGINES
K. W. TOBIN, JR., D. L. BESHEARS, W. D. TURLEY, W. LEWIS, III, and B. W. NOEL (Los Alamos National Lab., NM.) Aug. 1991 10 p Presented at the SPIE Meeting, Boston, MA, 3-6 Sep. 1991
(Contract DE-AC05-84OR-21400; W-7405-ENG-36)
(DE92-003539; CONF-9109230-7) Avail: NTIS HC/MF A02
Determination of blade temperatures in the high speed and turbulent environment of a turbine engine is difficult using standard pyrometry techniques because of the presence of high temperature flame and the reflective nature of the inspection surfaces. A technique utilizing thermographic phosphor compounds bonded to engine vanes and turbine blades is presented that mitigates the negative effects of blackbody radiation while potentially allowing near real time acquisition of blade temperature information. Specialized single and dual fiber optic probes were designed to interrogate both fixed and rotating surfaces by delivering ultraviolet light from a quadrupled Nd:YAG (266 nm) laser to phosphor coatings consisting of Y2O3:Eu, YVO4:Eu, and YAG:Tb ceramic compound. This technique utilizes the temperature dependent fluorescent emission of a ceramic phosphor coating to discern the temperature of the interrogated surface. By using these methods, surface temperature measurements to 1200 C are achievable in the combustion environment. DOE

N92-18728# Cranfield Inst. of Tech., Bedford (England). School of Mechanical Engineering.
ADVANCED TACTICAL FIGHTER ENGINE M.S. Thesis
R. DAVIS Sep. 1990 192 p Sponsored by Ministry of Defence Procurement Executive
(ETN-92-90840) Copyright Avail: NTIS HC/MF A09
The design of an aeroengine suitable to power the Advanced Tactical Fighter (ATF), a supersonic, long range tactical fighter aircraft being developed in the U.S. is detailed. The specification for a similar long range fighter was used to provide the engine specification. Both turbojet and turbofan cycles were fully investigated at design point, and off design, before selecting the turbofan cycle for further study and optimization. Having optimized the turbofan cycle, the design of the cycle as an aft fan and the design of a conventional turbofan were investigated and the two designs were compared and contrasted. The suitability of the aft fan as a powerplant for the ATF was assessed. ESA

N92-18867# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
OPTIMIZATION OF TANGENTIAL MASS INJECTION FOR MINIMIZING FLOW SEPARATION IN A SCRAMJET INLET M.S. Thesis
RICHARD J. KACIK Dec. 1991 294 p
(AD-A243868; AFIT/GAE/ENY/91D-2) Avail: NTIS HC/MF A13 CSCL 21/5
With the reemergence of interest in air-breathing hypersonic propulsion, scramjet inlet efficiency has become an area of concern. The impingement of the engine cowl shock near the shoulder (expansion corner between forebody and combustor) may cause boundary layer separation which reduces inlet efficiency. Tangential mass injection (TMI) upstream of the shoulder has recently been tested to control this separation but without much parametric evaluation. To resolve this deficiency, a 2-D scramjet inlet model with variable length cowl, and TMI was built and tested in the WL Mach 6 High Reynolds Number Facility. Parameters varied were boundary layer thickness, TMI flow rate, cowl position, cowl and shoulder angle, and slot to shoulder distance. The optimum slot location was determined by finding the minimum injection flow rate required to eliminate separation for each configuration and analyzing the trends. The test results, along with a simplified mixing theory based on maximizing the jet/freestream wake mass flux, indicated that the optimum slot location was 5-6 slot heights upstream of the shoulder. However, this result was somewhat obscured by the observation that, when the cowl shock impinged closer to (but downstream of) the slot or aft of the shoulder, less mass injection was required to eliminate separation. A typical TMI rate for controlling the shock-induced separation in these regions was 3-6 percent of the inlet captured mass flow. GRA

N92-19097# Minnesota Univ., Minneapolis. Heat Transfer Lab.
STUDIES OF GAS TURBINE HEAT TRANSFER: AIRFOIL SURFACES AND END-WALL COOLING EFFECTS Final Report, Apr. 1989 - Apr. 1991
E. R. ECKERT, R. J. GOLDLSTEIN, S. V. PATANKAR, and T. W. SIMON Sep. 1991 46 p
(Contract F49620-89-C-0060)
(AD-A244055; AFOSR-91-0954TR) Avail: NTIS HC/MF A03 CSCL 13/1
The report documents accomplishments made toward understanding the fluid flow and heat transfer processes in gas

turbines at the University of Minnesota over the past two years. The research is divided into three subtopics: studies of film cooling, airfoil surface heat transfer and endwall flow and heat transfer. Film cooling experiments show the effects of interaction among jets on curved surfaces and calculations show that parabolic techniques give accurate effectiveness predictions in regions away from injection holes. The surface heat transfer program showed that tripping the flow or roughening the wall has a clear effect near airfoil transition and separation points and that recovery from concave curvature is surprisingly slow. Endwall studies show flow visualization on the cascade endwall and the value of a fence on the endwall for rerouting the horseshoe vortex away from the suction wall. GRA

N92-19184# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
EFFECT OF NONUNIFORM ENTRANCE FLOW PROFILE ON HYPERSONIC NOZZLE PITCHING MOMENT M.S. Thesis
SANDRA L. SNELLING Dec. 1991 106 p
(AD-A244050; AFIT/GA/ENY/91D-13) Avail: NTIS HC/MF A06
CSCL 21/5

The Scramjet Hypersonic Nozzle (SCHNOZ) parabolized Navier-Stokes computer code was used to model turbulent, chemically reacting flow present in a hypersonic nozzle. Two nozzle configurations were considered, an isolated nozzle (no external flow) and a nozzle with a finite length cowl. A single nonuniform entrance flow profile was generated and an equivalent uniform flow profile calculated for input into the nozzle code. Uniform and nonuniform cases for each nozzle were run using both frozen and finite rate chemistry. An increased grid resolution in the computer code was necessary to eliminate numerically induced anomalies in the results of the nonuniform cases for both nozzle configurations. Comparisons between the finite rate and frozen flow cases showed that chemistry was essentially frozen for the finite rate cases, indicating that for the nozzle inlet conditions and geometry used in this study, the extra computational time spent on finite rate kinetics was unnecessary. The effects of the nonuniform flowfield used in this study included an increase in the overall vehicles thrust and a decrease in the overall vehicle moment. GRA

N92-19235# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
EXPERIMENTAL INVESTIGATION INTO THE EFFECTS OF RIBLETS ON COMPRESSOR CASCADE PERFORMANCE M.S. Thesis
JAMES A. ROTHENFLUE Dec. 1991 137 p
(AD-A243881; AFIT/GAE/ENY/91D-5) Avail: NTIS HC/MF A07
CSCL 21/5

The effects of adding riblets to the blades of a subsonic, linear compressor cascade were investigated at the Air Force Institute of Technology. Three blade configurations were tested, including a set of unmodified NACA 64-A905 series blades, a set with riblets applied to the suction surface, and a set with riblets on the pressure surface. Performance was evaluated over a wide range of Reynolds numbers, and at low and high free stream turbulence levels. Cascade performance was evaluated in terms of total pressure loss coefficient, turning angle, and static pressure rise. No riblet configuration offered robust cascade performance improvements; however, performance was significantly enhanced under certain specific conditions. Riblets also degraded cascade performance at other conditions. GRA

N92-19328# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
THE EFFECT OF ANGLE OF INCIDENCE AND REYNOLDS NUMBER ON HEAT TRANSFER IN A LINEAR TURBINE CASCADE M.S. Thesis
STEVEN MESCHWITZ Dec. 1991 188 p
(AD-A243900; AFIT/GAE/ENY/91D-6) Avail: NTIS HC/MF A09
CSCL 21/5

The AFIT linear Turbine Cascade Test Facility was used to study the effect of the small changes in the angle of incidence on turbine blade convective heat transfer. Other parameters studied were the model Reynolds number and the freestream turbulence level. Characterization tests, performed to determine the feasibility of the study were followed by a series of tests designed to separate the effects of the angle of incidence, Reynolds number, and freestream turbulence level on convective heat transfer. For any given freestream turbulence level or angle of incidence, there is an increase in the heat transfer coefficient for an increase in the Reynolds number. For the low freestream turbulence (0.5 pct.) configuration at a given Reynolds number, there is a decrease in the convective heat transfer coefficient with an increase in the angle of incidence, partially a result of the decrease in the cascade passage velocity and partially a result of the variation in boundary layer behavior. For the high freestream turbulence configuration (10 pct.) at any Reynolds number, there is an obvious increase in the convective heat transfer coefficient over that for the low turbulence configuration; however, the transitional or fully turbulent boundary layer makes it difficult to observe any relation between the convective heat transfer coefficient and the angle of incidence. GRA

N92-19329# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.
EXPERIMENTAL INVESTIGATION OF TRAILING EDGE CRENULATION EFFECTS ON LOSSES IN A COMPRESSOR CASCADE M.S. Thesis
STEVEN J. DECOOK Dec. 1991 117 p
(AD-A243902; AFIT/GAE/ENY/91D-1) Avail: NTIS HC/MF A06
CSCL 21/5

The effects of blade trailing edge crenulations on wake losses in a compressor cascade were investigated at the Air Force Institute of Technology. The cascade used NACA 64-A905 blades with a turning angle of about 30 to model last row stators of an axial flow compressor. Three blade configurations were used: unmodified blades, blades with large crenulations, and blades with small crenulations. Wake losses and mixing were evaluated in four flow conditions, generated by combinations of increased freestream turbulence and sidewall boundary layer removal. Injection of air perpendicular to the inlet flow increased freestream turbulence from about 0.15 to about 4 pct. The sidewall boundary layers could be removed by suction through sidewall slots immediately ahead of the cascade. A total pressure wake measured the difference between upstream and downstream total pressure, yielding pressure loss and velocity data, and hot wire anemometry was used downstream from the cascade to measure flow angle, relative turbulence, and velocity. For each test condition, the crenulated blades decreased total pressure loss, the wake velocity deficit, and wake velocity variance by about 10 to 20 pct., while slightly decreasing turning angle and increasing the turbulence level. The size of the crenulations had a small effect on these parameters. GRA

N92-19726*# General Electric Co., Cincinnati, OH. Aircraft Engine Business Group.
COMPONENT-SPECIFIC MODELING Final Report
R. L. MCKNIGHT, R. J. MAFFEO, M. T. TIPTON, and G. WEBER
Jan. 1992 109 p
(Contract NAS3-23687)
(NASA-CR-189088; NAS 1.26:189088) Avail: NTIS HC/MF A06
CSCL 21/5

Accomplishments are described for a 3 year program to develop methodology for component-specific modeling of aircraft hot section components (turbine blades, turbine vanes, and burner liners). These accomplishments include: (1) engine thermodynamic and mission models, (2) geometry model generators, (3) remeshing, (4) specialty three-dimensional inelastic structural analysis, (5) computationally efficient solvers, (6) adaptive solution strategies, (7) engine performance parameters/component response variables decomposition and synthesis, (8) integrated software architecture and development, and (9) validation cases for software developed. Author

N92-19938# Rolls-Royce Ltd., Derby (England).
MATERIALS AND PROCESS DIRECTIONS FOR ADVANCED AERO-ENGINE DESIGN
D. DRIVER 15 Nov. 1990 21 p Presented at the High Temp. Materials for Powder Engineering, Liege, Belgium, 1990 Previously announced in IAA as A91-52506 Submitted for publication
(PNR-90814; ETN-92-90782) Copyright Avail: NTIS HC/MF A03

A view of future air transport projections is given and how the resulting new aeroengine design will influence materials and processing technology is assessed. Modern military aircraft require gas turbines of mechanically simple design with few highly loaded components operating at high turbine entry temperatures in order to achieve high thrust to weight ratios. For civil aircraft the need for low cost of ownership leads to fuel efficient ultrahigh bypass ratio turbofan engines with relatively low purchase and maintenance costs and with extended component life reliability. The associated demands in materials technology are for high specific strength and stiffness, increased temperature capability and for manufacturing processes which enable components with tailored microstructures and properties to be made in a consistent and cost effective manner. The trend towards 'designer materials' is already being demonstrated with single crystal technology and with thermomechanically and powder processed components, but future demands will require a move from monolithic materials to more complex metal matrix, intermetallic, glass and ceramic composite structures, often involving manufacturing routes where the material and the component are made in the same processing operation. ESA

N92-19939# Rolls-Royce Ltd., Derby (England). Civil Powerplant Technology Div.
RE-ENGINING APPEARS TO OFFER BEST PAYBACK FOR YOUNG: CHAPTER 2 COMPLIANT AIRCRAFT
M. J. T. SMITH 15 Nov. 1990 4 p Repr. from ICAO Journal, Nov. 1990 p 12-14 Previously announced in IAA as A91-29053
(PNR-90848; ETN-92-90798) Copyright Avail: NTIS HC/MF A01

As a result of aircraft noise regulations, Chapter 2 compliant aircraft are faced with the prospect of enforced retirement by around the year 2000, and a tougher action at airports even earlier. The options for the older aircraft owner are in increasing order of cost: to do nothing, operating where the aircraft is acceptable for as long as possible, and then scrapping it (this is the obvious course of action with very old airframe); where technically possible to risk getting by with a bolt on hushkit, and then operating until further local noise constraints force scrapping; to rengine with a modern turbofan and, as a result, have an environmentally acceptable and valuable airframe as an asset (this option is attractive to owners of young airframes); to sell the aircraft while it still has resale value, and by a much more expensive replacement. The pros and cons of the 'hushkit' and 're-engine' options are considered. The re-engining option appears the most advantageous, having a whole array of benefits besides outstanding noise reduction, the hushkitting offering little real noise alleviation, especially at take off. ESA

N92-20033*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
NASA'S ROTARY ENGINE TECHNOLOGY ENABLEMENT PROGRAM: 1983-1991
EDWARD A. WILLIS (Sverdrup Technology, Inc., Brook Park, OH.) and JOHN J. MCFADDEN 1992 13 p Presented at the International Congress and Exposition, Detroit, MI, 24-28 Feb. 1992; sponsored by SAE
(NASA-TM-105562; E-6868; NAS 1.15:105562) Avail: NTIS HC/MF A03 CSCL 21/5

A brief review is provided of NASA's Rotary Engine Technology Enablement Program from 1983 through 1991, with primary emphasis on the CFD approaches used since 1987. The main discussion includes both code development and applications to several particularly difficult internal air flow, fuel air mixing, and combustion related problems. A summary of the final status of the technology is given. Author

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AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

A92-24408* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
FORWARD-LOOK WIND-SHEAR DETECTION FOR MICROBURST RECOVERY
DAVID A. HINTON (NASA, Langley Research Center, Hampton, VA) Journal of Aircraft (ISSN 0021-8669), vol. 29, Jan.-Feb. 1992, p. 63-66. Previously cited in issue 21, p. 3273, Accession no. A89-48433. refs
Copyright

A92-24413
EFFECTS OF TRAILING-EDGE FLAP ON BUFFET CHARACTERISTICS OF A SUPERCRITICAL AIRFOIL
B. H. K. LEE (National Research Council of Canada, Ottawa) Journal of Aircraft (ISSN 0021-8669), vol. 29, Jan.-Feb. 1992, p. 93-100. Previously announced in STAR as N91-14327. refs
Copyright

The buffet characteristics of a 16 percent thickness-to-chord ratio supercritical airfoil were investigated in the High Reynolds Number Two-Dimensional Test Facility of the National Aeronautical Establishment. The trailing-edge flap dimension was 13.5 percent chord and it was deflected at various angles to study the effect of modifying the downstream pressure on controlling flow separation over the airfoil. The unsteady normal force was measured and the buffet boundary was determined from the divergence of the fluctuating normal force. The investigation was conducted quite deep into the buffet regime. Spectral analyses of the normal force were carried out and the frequencies of shock wave oscillations were measured. They were found to be Mach number dependent and varied between 50 to 80 Hz for $M = 0.612$ to 0.792. The effects of varying the flap angles on the shock wave position and drag of the airfoil were also investigated. Results for an off-design Mach number of 0.612 were given in some details. Author

A92-24427
YAW DYNAMICS OF A COAXIAL ROTOR HELICOPTER
LEONID STACHTCHENKO and THEODORE VALKOV (Bombardier, Inc., Reconnaissance Systems Div., St.-Laurent, Canada) La Recherche Aerospatiale (English Edition) (ISSN 0379-380X), no. 4, 1991, p. 11-22. refs
Copyright

This paper deals with the yaw dynamics of a coaxial rotor helicopter. It presents a new and efficient concept for controlling such a vehicle in yaw. The use of a differential gearing system allows a substantial reduction of the body yaw torque and facilitates the yaw control. Yaw control is achieved by the application of a braking torque on either of the rotor shafts. The braking torque can be applied directly to the shaft, or by means of torque transfer from the other rotor. The latter method is more efficient, but it is operational only within a specific interval of rotational speed difference between the rotors. This differential speed depends on the difference between the torques applied to the rotors. A relatively simple method, considering the aerodynamic interaction between the rotors, was developed to compute the torque difference. It agrees well with the experimental results. Author

A92-24879
OPEN-LOOP MODEL REDUCTION AND PARAMETER PERTURBATION FOR ACTIVE FLUTTER SUPPRESSION SYSTEM
ZENG HE and SONGNIAN GU (Northwestern Polytechnical University, Xian, People's Republic of China) Northwestern Polytechnical University, Journal (ISSN 1000-2758), vol. 10, Jan. 1992, p. 21-30. In Chinese. refs
For the convenience of preliminary control design and analysis, a reduced open-loop model is to be preferred over the full model. Such a model reduction, based on Chidambara's modal aggregation is obtained. The errors of parameter perturbation are successfully kept within allowable limits. Numerical results show that the reduced model is a good approximation of the full model. Author

A92-25010
THE CALCULATION OF THE STATIC ELASTIC AERODYNAMIC DISTRIBUTION FOR THE ROLLING MANEUVER AIRCRAFT
ZHIQIANG ZHOU and QIANGANG LIU (Northwestern Polytechnical University, Xian, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 9, Dec. 1991, p. 449-456. In Chinese. refs
The unsymmetrical aerodynamic loads on the wings caused by the deflection of the aileron can create much larger torsion and bending moments on the wings than those by symmetrical ones. The aircraft's motion parameters are calculated using equations with five-degree of freedom. The aileron deflection angle, normal load, and angular velocity in roll when the aircraft makes the rolling maneuver are obtained. Finally the static elastic aerodynamic and static deformation distributions of a combat aircraft are calculated using the Green function method, including the rolling damping effect. Author

A92-25733*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
REDUCTION OF WING ROCK AMPLITUDES USING LEADING-EDGE VORTEX MANIPULATIONS
JAMES WALTON and JOSEPH KATZ (San Diego State University, CA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 8 p. refs
(Contract NCC2-458)
(AIAA PAPER 92-0279) Copyright
A mechanically operated leading edge flap system was used to perturb leading edge vortex position on a free-to-roll double-delta wing. The motion of the flaps was synchronized with the wing rolling oscillations and the effect of the phase shift between the oscillations of the wing and the flaps was investigated. Experimental results indicated that this simple approach was effective in reducing the amplitude of the unintended rolling motion and its implementation to actual airplane configurations is rather simple. Author

A92-27043#
EVALUATION OF METHODS FOR ESTIMATING STORE CARRIAGE LOADS
A. CENKO (U.S. Navy, Naval Air Development Center, Warminster, PA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 9 p. refs
(AIAA PAPER 92-0675)
MIL-A-8591 (1983) is evaluated for estimating store carriage loads. Test data for various stores are compared with the standard estimates to determine the validity of MIL-A-8591 procedures, and modifications for improving the standard are proposed. O.G.

A92-27082# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
TARGET PITCH ANGLE FOR THE MICROBURST ESCAPE MANEUVER
SANDEEP S. MULGUND and ROBERT F. STENGEL (Princeton University, NJ) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 10 p. Research sponsored by FAA. refs
(Contract NGL-31-001-252)
(AIAA PAPER 92-0730) Copyright
Recovery performance of a commuter-type aircraft in a microburst encounter is studied using a constant-pitch-attitude strategy and flight path optimization. Results obtained indicate that the pitch attitude which maximized climb rate in a wind shear condition is strongly dependent on whether the aircraft is subjected to a horizontal shear or a downdraft. The pitch attitude which maximizes ground clearance depends on the altitude of the encounter, the strength of the microburst, and the initial position of the aircraft with respect to the downburst core. Best results are obtained at relatively low target pitch angles, in severe wind shear encounters at very low altitudes. A technique for maximizing ground clearance involves maintaining a low pitch attitude early in the encounter, followed by a gradual pitch-up that ceases when the wind shear has been excited. O.G.

A92-27083#
2-D AND 3-D MINIMUM-TIME-TO-TURN FLIGHTS VIA PARAMETER OPTIMIZATION
SHAW Y. ONG and BION L. PIERSON (Iowa State University of Science and Technology, Ames) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 10 p. refs
(AIAA PAPER 92-0731) Copyright
Several two- and three-dimensional minimum-time-to-turn problems for a jet fighter are solved using sequential quadratic programming. The original optimal control problem is transformed into a constrained parameter optimization problem by discretizing the vector of control functions into an appropriate number of control points. A complete point-mass aircraft dynamic model is used. Numerical results as well as comparisons between two- and three-dimensional optimal turning flights are presented for an early version of the F-4 fighter aircraft. Author

A92-27826
A STUDY OF ACTIVE FLUTTER SUPPRESSION FOR A WING/STORE SYSTEM
QIKAI CAO (Shenyang Aircraft Co., People's Republic of China) and GUIBIN CHEN (Beijing University of Aeronautics and Astronautics, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, Oct. 1991, p. B453-B458. In Chinese. refs
The control laws of an active flutter-suppression system for a low-aspect-ratio wing-flutter model with an outboard missile are studied. The model is equipped with an outboard trailing-edge control surface. According to all dynamic characteristics and rigid characteristics of the model, a second-order control law is designed using a dynamic compensator method based on optimum control. The control law is tested by the simulator during wind-tunnel test. The experimental results indicate that the flutter critical speed increases by more than 14 percent. The calculated results are in good agreement with the experimental ones. Author

A92-27914
A NEW APPROACH TO DETERMINING CONTROL SURFACE'S MOMENTS OF INERTIA WITH TEST-TWICE VIBRATIONS APPROACH
ZHENQU TAO (Shanghai Aircraft Research Institute, People's Republic of China) Nanjing Aeronautical Institute, Journal (ISSN 1000-1956), vol. 24, Feb. 1992, p. 112-114. In Chinese. refs
A new approach to determining the moments of inertia of the control surface or tab about its hinge line is presented. When determining the moments of inertia with this approach, it is not necessary to determine the mass of the control surface and the location of the centroid. Therefore, less testing equipment is needed, and testing accuracy is increased. Author

A92-28151* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
FLIGHT INVESTIGATION OF VARIATIONS IN ROTORCRAFT CONTROL AND DISPLAY DYNAMICS FOR HOVER
MICHELLE M. ESHOW (NASA, Ames Research Center, Moffett

Field, CA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 15, Mar.-Apr. 1992, p. 482-490. Previously cited in issue 21, p. 3317, Accession no. A90-47731. refs
Copyright

A92-28152* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
HIGH-ALPHA APPLICATION OF VARIABLE-GAIN OUTPUT FEEDBACK CONTROL
AARON J. OSTROFF (NASA, Langley Research Center, Hampton, VA) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 15, Mar.-Apr. 1992, p. 491-497. Previously cited in issue 23, p. 3621, Accession no. A89-52659. refs
Copyright

A92-28153
ABSTRACT MODEL AND CONTROLLER DESIGN FOR AN UNSTABLE AIRCRAFT
DALE ENNS (Honeywell, Inc., Minneapolis, MN), HITAY OZBAY (Ohio State University, Columbus), and ALLEN TANNENBAUM (Minnesota, University, Minneapolis) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 15, Mar.-Apr. 1992, p. 498-508. refs
(Contract NSF DMS-88-11084; AF-AFOSR-90-0024; DAAL03-91-G-0019)
Copyright

An unstable system with a time delay is considered as an abstract model of an aircraft longitudinal motion for the short period. Both sensitivity reduction and robustness to certain unmodeled dynamics are wanted in the controller design. Using standard arguments, these control objectives are formulated as an H(infinity) optimal control problem. It is shown in detail how to compute the optimal controller for this distributed model (and not for a finite dimensional approximation). A numerical example is given to illustrate the computational procedure. Certain properties of the controller are discussed for this example. Author

A92-28154
IMPROVED NOISE REJECTION IN AUTOMATIC CARRIER LANDING SYSTEMS
D. J. MOOK, DOUGLAS A. SWANSON, MICHAEL J. ROEMER (New York, State University, Buffalo), and ROGER NOURY (Bell Aerospace Textron, Buffalo, NY) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 15, Mar.-Apr. 1992, p. 509-519. Previously cited in issue 21, p. 3315, Accession no. A90-47632. refs
Copyright

N92-18294# Manchester Univ. (England). Aeronautical Engineering Group.
MODEL PARAMETER IDENTIFICATION TECHNIQUES FOR FLIGHT FLUTTER TESTING
J. E. COOPER 1991 30 p Presented at 71st AGARD Structures and Materials Panel, Povoa de Varzin, Portugal, 8-10 Oct. 1990
(AERO-REPT-9105; ETN-92-90936) Avail: NTIS HC/MF A03

The most popular modal parameter identification techniques and the comparative exercises involving them are reviewed. A survey of the application of such methods in flight flutter tests is undertaken. A survey and some form of round robin procedure are deemed necessary in order to establish the effective use of system identification techniques for flight flutter testing. ESA

N92-18321# Manchester Univ. (England). Aeronautical Engineering Group.
AIRCRAFT AERODYNAMICS AND STABILITY AND CONTROL DURING AIR-TO-AIR REFUELING Ph.D. Thesis
VASSILIOS TROCHALIDIS May 1990 140 p Sponsored by Science Research Council and Ministry of Defence
(AERO-REPT-9017; ETN-92-90940) Avail: NTIS HC/MF A07

A study aimed at the development of an analytical model capable of representing any combination of tanker and receiver aircraft in an Air to Air Refueling (AAR) configuration is presented. A theoretical analysis of the problem with requirements for theoretical models is given. Individual theories such as lifting line, horseshoe vortex, and vortex lattice method are given. Combination models are discussed. The experimental hardware and software is described. Experimental tests are described and measurements are plotted and compared with theoretical predictions. The longitudinal aerodynamic interference between large receiver and radar aircraft during AAR is addressed. Results from an investigation into the lateral aerodynamics and stability and control of a VC10/Hercules tanker/receiver combination are presented. ESA

N92-18791*# Eidetics International, Inc., Torrance, CA.
AERODYNAMIC CONTROL OF FIGHTER AIRCRAFT BY MANIPULATION OF FOREBODY VORTICES
GERALD N. MALCOLM and T. TERRY NG *In* AGARD, Manoeuvring Aerodynamics 22 p Nov. 1991
(Contract NAS2-13155; F33615-86-C-3623)
Copyright Avail: NTIS HC/MF A13; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Methods of enhancing aircraft controllability and maneuverability at high angles of attack by manipulating the forebody vortices are discussed. Pneumatic control methods including jet blowing, slot blowing, and suction, and mechanical control methods using forebody and nose tip strakes are reviewed. The potential of various control devices in controlling the forebody flow, and thus, providing controlled yawing moments at high angles of attack are illustrated using wind tunnel results from a generic fighter and water tunnel results from an F/A-18. Author

N92-18792# Wright Lab., Wright-Patterson AFB, OH.
FOREBODY VORTEX CONTROL AEROMECHANICS
ROBERT W. GUYTON, RUSSELL F. OSBORN, and SCOTT P. LEMAY *In* AGARD, Manoeuvring Aerodynamics 14 p Nov. 1991
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Forebody vortex flow characteristics are discussed in terms of the forebody flowfield aerodynamics and the impact of this flow on the resulting forces and moments that limit combat maneuverability. Test results are presented for several pneumatic forebody vortex control designs applied to a 1/8 scale X-29 model, a 1/15 scale F-16 model, and a 55 degree cropped delta/chined forebody model representative of future fighter configurations. Author

N92-18793# Royal Aerospace Establishment, Farnborough (England). Aerodynamics Dept.
DYNAMIC WIND TUNNEL TESTS ON CONTROL OF FOREBODY VORTICES WITH SUCTION
A. JEAN ROSS, E. B. JEFFERIES, and GERALDINE F. EDWARDS *In* AGARD, Manoeuvring Aerodynamics 12 p Nov. 1991
Copyright Avail: NTIS HC/MF A13; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Extensive static and dynamic experiments were made in low speed wind tunnels to investigate the possibility of using the yawing moment due to asymmetric forebody vortices for control at high angles of attack. The relative positions of the two vortices arising near the nose apex can be changed by applying differential suction through two small holes very near the tip. The resulting forces and moments measured in static tests were analyzed for the effects of forebody diameter and slenderness ratio. The Royal Aeronautical Establishment (RAE) High Incidence Research Model was controlled successfully on a free-to-yaw rig, indicating that the system could be used in flight. However, it could be expected that there are significant lags in the generation of the aerodynamic forces and moments. Experiments were conducted on a simple missile model mounted on a string rig, to measure the responses in yawing moment and sideforce due to sinusoidal variation over a range of frequencies of flow rates through suction holes. The implications of these results for the proposed free-flight model tests are discussed. Author

N92-18795# Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.).
AEROSERVOELASTIC STABILITY OF AIRCRAFT AT HIGH INCIDENCE
JUERGEN BECKER *In* AGARD, Manoeuvring Aerodynamics 20 p Nov. 1991
Copyright Avail: NTIS HC/MF A13; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The aeroservoelastic stability of a fighter type aircraft is investigated at high angle of attack. The effects of nonlinear, incidence dependent unsteady aerodynamic forces of elastic modes and of control surface deflections on the structural coupling are demonstrated for low and high subsonic speeds for different incidences. The difference of open loop frequency response functions calculated with linear and with high angle of attack unsteady aerodynamics documents the necessity of the introduction of high incidence effects for aeroservoelastic stability calculations. Nonlinear effects are introduced using unsteady pressures of wind tunnel experiments on an oscillating model by correction of theoretical pressures. Author

N92-18893# National Aerospace Lab., Amsterdam (Netherlands). Flight Div.
DEVELOPMENT OF NONLINEAR REAL-TIME HELICOPTER SIMULATION USING A BLADE ELEMENT METHOD
W. BROUWER and L. MEERWIJK 31 Mar. 1990 27 p Presented at the Royal Aeronautical Society Conference on Progress in Helicopter and V/STOL Aircraft Simulation, London, England, 1-2 May 1990
(NLR-TP-90115-U; ETN-92-90969) Avail: NTIS HC/MF A03

The background of a program focused on extending its moving base research flight simulator facility with real time helicopter simulation, and its objectives and the approach to accomplish them are discussed. The available hardware systems (e.g., a multiprocessor computer system, a model board/television camera visual system, and motions systems) in combination with the development software contain sufficient capabilities to establish a helicopter research facility for research concerning handling qualities, digital control laws, man machine interface, etc. The procurements expected in the near future, a generic helicopter cockpit and a computer generated imagery visual system, will not only support but also increase these capabilities. Specific helicopter software modules ware developed and tested separately. At present, the modules are integrated within the comprehensive flight simulation program and off line validation are in progress. The helicopter software modules developed are outlined and suggestions for further improvements are given. ESA

N92-19174*# National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Facility, Edwards, CA.
LINEARIZED AERODYNAMIC AND CONTROL LAW MODELS OF THE X-29A AIRPLANE AND COMPARISON WITH FLIGHT DATA
JOHN T. BOSWORTH Feb. 1992 113 p
(NASA-TM-4356; H-1676; NAS 1.15:4356) Avail: NTIS HC/MF A06 CSCL 01/3

Flight control system design and analysis for aircraft rely on mathematical models of the vehicle dynamics. In addition to a six degree of freedom nonlinear simulation, the X-29A flight controls group developed a set of programs that calculate linear perturbation models throughout the X-29A flight envelope. The models include the aerodynamics as well as flight control system dynamics and were used for stability, controllability, and handling qualities analysis. These linear models were compared to flight test results to help provide a safe flight envelope expansion. A description is given of the linear models at three flight conditions and two flight control system modes. The models are presented with a level of detail that would allow the reader to reproduce the linear results if desired. Comparison between the response of the linear model and flight measured responses are presented to demonstrate the strengths and weaknesses of the linear models' ability to predict flight dynamics. Author

N92-19241# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
APPLICATION OF NONLINEAR QFT TO FLIGHT CONTROL DESIGN FOR HIGH ANGLE OF ATTACK MANEUVERS WITH THRUST VECTORING M.S. Thesis
STEVEN J. RASMUSSEN Dec. 1991 179 p
(AD-A243821; AFIT/GE/EN/91D-44) Avail: NTIS HC/MF A09 CSCL 01/4

Nonlinear Quantitative Feedback Theory (QFT) is applied to the design of a Flight Control System (FCS) to control maneuvers of an agile aircraft. To do this, maneuvers are chosen that are desirable during visual range combat. Plant transfer functions are developed through the use of system identification, using the input/output time histories of the maneuvers. During the system identification process the q (sub ij)(o) are found directly and are constrained to be minimum phase. After identifying the plants, the cascaded multiple-input multiple-output QFT technique is used to design the FCS. During the design of the FCS, stability boundaries are generated through the use of a Matrix sub x program. To prevent the formation of large RHP poles, Gamma-boundaries are developed. Before shaping the loops it is found that FCS scheduling is needed because of large uncertainty in the magnitude and phase of the plants. Because the orders of the designed controllers are too large for the YF-16 simulation program, reduced order controllers are developed through the use of straight line approximations on the Bode plot. After implementing the reduced order controllers in the nonlinear simulation program, problems developed in the modeling process are encountered that prevent the simulation of the FCS's. GRA

N92-19295# Centre d'Etudes et de Recherches, Toulouse (France). Dept. d'Etudes et de Recherches en Automatique.
DOUBLE LOOP CONTROL LAW STRATEGY AND APPLICATIONS TO HELICOPTER Interim Report [STRATEGIE DE LOI DE COMMANDE A 2 BOUCLES ET APPLICATIONS A L'HELICOPTERE. RAPPORT INTERMEDIAIRE]
CHRISTIANE SAMBLANCAT, JEAN-FRANCOIS MAGNI, PIERRE APKARIAN, and PHILIPPE MOUYON Mar. 1991 81 p In FRENCH
(Contract DRET-89-002-36-1-3-4)
(CERT-2/7724-DERA; ETN-92-90871) Avail: NTIS HC/MF A05

A double loop command rule strategy using placement structure and H infinity synthesis is described. Transitory placement is treated by means of placement modes while the robustness and the permanent regime are considered via H infinity synthesis. The advantages of the method are illustrated through helicopter piloting, which is a practical problem involving movement uncoupling specifications as well as robustness in terms of the rotor dynamics which are not taken into consideration. ESA

N92-19499*# Boeing Commercial Airplane Co., Seattle, WA.
NASA TSRV ESSENTIAL FLIGHT CONTROL SYSTEM REQUIREMENTS VIA OBJECT ORIENTED ANALYSIS Final Report
KEITH S. DUFFY and BRADLEY J. HOZA Mar. 1992 199 p
(Contract NAS1-18027)
(NASA-CR-189573; NAS 1.26:189573) Avail: NTIS HC/MF A09 CSCL 01/3

The objective was to analyze the baseline flight control system of the Transport Systems Research Vehicle (TSRV) and to develop a system specification that offers high visibility of the essential system requirements in order to facilitate the future development of alternate, more advanced software architectures. The flight control system is defined to be the baseline software for the TSRV research flight deck, including all navigation, guidance, and control functions, and primary pilot displays. The Object Oriented Analysis (OOA) methodology developed is used to develop a system requirement definition. The scope of the requirements definition contained herein is limited to a portion of the Flight Management/Flight Control computer functionality. The development of a partial system requirements definition is documented, and includes a discussion of the tasks required to

increase the scope of the requirements definition and recommendations for follow-on research. Author

N92-19505# Air Force Inst. of Tech., Wright-Patterson AFB, OH. *School of Engineering.*
PROPORTIONAL PLUS INTEGRAL CONTROL OF AIRCRAFT FOR AUTOMATED MANEUVERING FORMATION FLIGHT M.S. Thesis
JOHN L. DARGAN *Dec. 1991* *184 p*
(AD-A243792; AFIT/GE/EN/91D-14) Avail: NTIS HC/MF A09 CSCL 01/4

In this study an automated formation control system for a lead and wing aircraft flight is developed. The proposed formation control system is capable of controlling like or dissimilar aircraft in maneuvering formation flight. Thus, two versions of the C-130 aircraft, the C-130A and the C-130B, are modelled. The C-130B has superior performance characteristics to that of the C-130A. The wing aircraft continuously measures lead aircraft position with an ideal on-board relative position sensor, maneuvering to maintain relative position. External formation guidance is assumed to be released in a single data burst, consisting of formation geometry and nominal separation commands for each aircraft in the formation. No continuous communication is assumed between formation aircraft. Simulation of the formation control system reveals that a controller is needed to alleviate the steady state errors in separation distance after a formation maneuver is executed. Hence, a Proportional plus Integral formation system control has been developed, which allows aircraft with differing performance capabilities to safely and effectively execute all maneuvers evaluated in the study. Moreover, the formation control system is shown to satisfactorily operate independently of the aircraft or formation configuration being flown. There is zero steady state error for all maneuver and separation distance responses, and the transients are such that no collision occurs between the aircraft in the formation. GRA

N92-19621 Oxford Univ. (England).
ROBUST CONTROL SYSTEM DESIGN WITH APPLICATION TO HIGH PERFORMANCE HELICOPTERS Ph.D. Thesis
MICHAEL STANLEY TOMBS 1987 225 p
Avail: Univ. Microfilms Order No. BRD-93833

One of the first applications of H-infinity optimization to the design of controllers for industrial problems is presented. The system considered was an unstable helicopter model, obtained from a larger nonlinear simulation configured to represent future high performance helicopters. The problem was to design a full authority flight control system, to stabilize the aircraft and decouple the controlled inputs, thus reducing pilot workload. Robustness was a primary issue because of model uncertainty, particularly due to the omission from the design model of higher order rotor dynamics. The optimization problem was based on the minimization of sensitivity (for performance) and control output (for robustness) transfer functions. Simple weighting functions were found to be useful for examining the fundamental performance versus robustness tradeoff, and to be more effective at shaping the closed loop transfer functions than LQG/LTR techniques. An important improvement to the H-infinity optimization solution process was the development of a numerically reliable algorithm to perform minimal realization. Dissert. Abstr.

N92-19841*# Oregon State Univ., Corvallis. Dept. of Electrical and Computer Engineering.
NONLINEAR STABILITY AND CONTROL STUDY OF HIGHLY MANEUVERABLE HIGH PERFORMANCE AIRCRAFT, PHASE 2 Semiannual Report
R. R. MOHLER 14 Feb. 1992 64 p
(Contract NAG1-1081)
(NASA-CR-189911; NAS 1.26:189911; OSU-ECE-92-01) Avail: NTIS HC/MF A04 CSCL 01/3

Research leading to the development of new nonlinear methodologies for the adaptive control and stability analysis of high angle of attack aircraft such as the F-18 is discussed. The emphasis has been on nonlinear adaptive control, but associated model development, system identification, stability analysis, and simulation were studied in some detail as well. Studies indicated that nonlinear adaptive control can outperform linear adaptive control for rapid maneuvers with large changes in angle of attack. Included here are studies on nonlinear model algorithmic controller design and an analysis of nonlinear system stability using robust stability analysis for linear systems. Author

N92-20026# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Guidance and Control Panel Working Group 9.
VALIDATION OF FLIGHT CRITICAL CONTROL SYSTEMS
GORDON BELCHER, ed., DUNCAN E. MCIVER, ed., and KENNETH J. SZALAI, ed. Dec. 1991 136 p
(AGARD-AR-274; ISBN-92-835-0650-2) Copyright Avail: NTIS HC/MF A07; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The objectives of the research is the following: (1) to provide guidance to those concerned in the Flight Critical Control System (FCCS) validation, namely systems designers and certification authorities; and (2) to identify the areas of research which need to be explored to enable validation of the next generation of FCCS. An attempt was made to review all flight critical control system validation activities which had been completed or were under active consideration, in Europe and the U.S. Author

09

RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tube facilities; and engine test blocks.

A92-24406* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
INVESTIGATION OF THE DIFFUSER FLOW QUALITY IN AN ICING RESEARCH WIND TUNNEL
HAROLD E. ADDY, JR. (NASA, Lewis Research Center, Cleveland, OH) and THEO G. KEITH, JR. (Toledo, University, OH) Journal of Aircraft (ISSN 0021-8669), vol. 29, Jan.-Feb. 1992, p. 47-51. Previously cited in issue 10, p. 1442, Accession no. A89-28455. refs
Copyright

A92-24729
A LARGE-SCALE AXIAL FLOW COMPRESSOR FACILITY AND DYNAMIC MEASUREMENT TECHNIQUES FOR ROTOR FLOW STUDY
HAOKANG JIANG, YUCHUN LI, HONG ZHANG, ZHANG XIONG, LIPIN XU, and MAOZHANG CHENG (Beijing University of Aeronautics and Astronautics, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, Jan. 1992, p. 1-8. In Chinese. refs

A large-scale axial flow compressor research facility designed for relative flow measurements is presented. With a test section outer diameter of one meter and hub/tip ratio of 0.6, the facility has a unique rotating-probe traversing mechanism downstream of the rotor blade row and inside the hub which can traverse various probes across the rotor blade passage. The precise null, tangential, radial, and axial motions of the probes are entirely electrical and controlled by an online microcomputer. The data transmission system consists of rotating pressure transducers and a multichannel slip ring. High-response probes fixed on stationary probe traverse mechanisms are used for rotor exit flow measurements. A computer-controller 16-channel parallel data acquisition and processing system with maximum ampling frequency of 100 KHz per channel is used to acquire data. Typical data on the 3D flow structure at the rotor exit and inlet are presented. C.D.

A92-25110
NEW METHOD FOR BOUNDARY LAYER THICKNESS CONTROL ON GROUND PLATE IN WIND TUNNEL
YONGDING XU and JIAKUN HAN (Beijing Institute of Aerodynamics, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 9, Sept. 1991, p. 361-366. In Chinese. refs

A new method is described for boundary layer thickness control on the fixed ground plate in a wind tunnel. The ground plate with this control is named (ISS) internal-suction-slotted ground plate. From the experimental results of the flow over the ISS ground plate in a 3m x 3m wind tunnel it is indicated that such control method can not only effectively decrease the boundary layer thickness, but also bring smaller interference to the flow field quality. This method is recommended in comparison with others for the boundary layer thickness control on ground plates in wind tunnels. Author

A92-25774*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
REACTIVATION AND UPGRADE OF THE NASA AMES 16-INCH SHOCK TUNNEL - STATUS REPORT
DAVID W. BOGDANOFF, HORACIO A. ZAMBRANA (Eloret Institute, Palo Alto, CA), JOHN A. CAVOLOWSKY, MARK E. NEWFIELD, CHARLES J. CORNELISON, and ROBERT J. MILLER (NASA, Ames Research Center, Moffett Field, CA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 8 p. refs
(Contract NCC2-487)
(AIAA PAPER 92-0327)

The NASA Ames 16-Inch Shock Tunnel has been reactivated after seventeen years of inactivity. In the years before deactivating the facility, it was operated at enthalpies of 4,700 J/gm and pressures up to 260 atm or at enthalpies of 1900 J/gm over a wide pressure range. Since reactivating, the facility has been operated at enthalpies up to 12,000 J/gm and pressures up to 408 atm. The present paper describes the steps taken in upgrading the facility and summarizes the currently achievable conditions. The selection of the driver gas, the steps taken to improve the driver burn, and the diaphragm opening techniques are described. The pressure and heat flux instrumentation, the optical diagnostics and the data acquisition system are also described. Author

A92-25776*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
HIGH PRESSURE HYPERVELOCITY ELECTROTHERMAL WIND TUNNEL PERFORMANCE STUDY AND SUBSCALE TESTS
OUSSAMA F. RIZKALLA, WALLACE CHINITZ (General Applied Science Laboratories, Ronkonkoma, NY), F. D. WITHERSPOON (GT-Devices, Inc., Alexandria, VA), and RODNEY L. BURTON (Illinois, University, Urbana) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 13 p. refs
(Contract NAS1-18450)
(AIAA PAPER 92-0329) Copyright

The feasibility of a Mach 10 to 20, high pressure electrothermal wind tunnel was assessed. A heater based on a continuous high power electric arc discharge capable of heating air to temperatures above 10,000 K and pressures of 15,000 atm is the key element of this wind tunnel. Results of analytical study indicate that the facility is capable of simulation conditions suitable for hypervelocity airbreathing propulsion testing up to Mach 16. In this case simulation was limited by pressure containment, high nozzle throat heat flux rates, and chemical freezing in the nozzle. The high total pressure capability improved the recombination chemistry in the facility nozzle as chemical equilibrium prevailed to the freezing point. Steady arc discharges were observed with liquid nitrogen flowing into the arc chamber during tests based on the two millisecond test facility. The measured steady pressure in the arc chamber was 4559 psi, which is two times greater than maximum total pressure obtainable in conventional arc heaters. O.G.

A92-25778*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
INITIAL OPERATION OF THE UTA SHOCK TUNNEL
FRANK K. LU (Texas, University, Arlington) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 12 p. refs
(Contract NAG1-891)
(AIAA PAPER 92-0331) Copyright

Initial experience in operating a small UTA (University of Texas at Arlington) shock tunnel at high Reynolds numbers for perfect gas simulation of hypersonic flow and boundary layer studies is described. Particular attention is given to tradeoffs between various constraints for achieving the test requirements, and methods for obtaining precise control of test conditions and protecting low-range pressure transducers from overpressure damage. O.G.

A92-26360
PRODUCTIVITY AND QUALITY IN THE MODANE AND FAUGA WIND TUNNELS - PROSPECTS FOR THE 90S [PRODUCTIVITE ET QUALITE DANS LES SOUFFLERIES DE MODANE ET DU FAUGA - LES PERSPECTIVES POUR LES ANNEES 90]
GERARD DOREY (ONERA, Chatillon, France) (L'Aeronautique et l'Astronautique, no. 148-149, 1991, p. 84-92) ONERA, TP no. 1991-203, 1991, 10 p. In French. refs
(ONERA, TP NO. 1991-203) Copyright

This paper presents the current state-of-the-art of the principal ONERA test facilities at the centers of Modane-Avrieux and Le Fauga-Mauzac, and discusses the present objectives to enhance quality and productivity. The aerodynamic facilities cover the entire Mach number regime from the low speeds of takeoff and landing to the very high velocities of acceleration and reentry in the earth's atmosphere. Attention is given to a program of modernization and development in synergy with the development of CFD, and in the framework of European cooperation. R.E.P.

A92-26371
TESTS OF MODELS EQUIPPED WITH A TURBOFAN POWERED SIMULATOR IN THE ONERA F1 LOW-SPEED PRESSURIZED WIND TUNNEL [ESSAIS DE MAQUETTES MOTORISEES EQUIPEES DE SIMULATEURS DE REACTEURS DANS LA SOUFFLERIE BASSE VITESSE PRESSURISEE F1, DE L'ONERA]
J. LEYNAERT (ONERA, Chatillon, France) (NATO, AGARD, Symposium on Aerodynamic Engine/Airframe Integration for High Performance Aircraft and Missiles, Fort Worth, TX, Oct. 7-11, 1991) ONERA, TP no. 1991-219, 1991, 6 p. In French. refs
(ONERA, TP NO. 1991-219)

The particular conditions of tests of models equipped with a turbofan powered simulator (TPS) at high Reynolds numbers in a pressurized wind tunnel are presented. The high-pressure air supply system of the wind tunnel, the equipment of the balance with the high-pressure traversing flow and its calibration, and the thrust calibration method of the TPS and its verification in the wind tunnel are described. R.E.P.

A92-26974*# National Aeronautics and Space Administration, Washington, DC.
AN IODINE HYPERSONIC WIND TUNNEL FOR THE STUDY OF NONEQUILIBRIUM REACTING FLOWS
G. C. PHAM-VAN-DIEP, E. P. MUNTZ, D. P. WEAVER, T. G. DEWITT, M. K. BRADLEY, D. A. ERWIN, and J. A. KUNC (Southern California, University, Los Angeles, CA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 22 p. Research supported by USAF and NASA. refs
(AIAA PAPER 92-0566) Copyright

A pilot scale hypersonic wind tunnel operating on pure iodine vapor has been designed and tested. The wind tunnel operates intermittently with a run phase lasting approximately 20 minutes. Successful recirculation of the iodine used during the run phase has been achieved but can be improved. Relevant issues regarding the full scale facility's design and operation, and the use of iodine as a working gas are discussed. Continuous wave laser induced fluorescence was used to monitor number densities within the

plume flowfield, while pulsed laser induced fluorescence was used in an initial attempt to measure vibrational energy state population distributions. Preliminary nozzle flow calculations based on finite rate chemistry are presented. Author

A92-26975#

EXPERIMENTS TO EVALUATE HOT-JET SIMULATION CAPABILITIES IN CRYOGENIC WIND-TUNNEL TESTING

KEISUKE ASAI and TAKEO AOKI (National Aerospace Laboratory, Tokyo, Japan) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 12 p. refs

(AIAA PAPER 92-0567) Copyright

In an attempt to demonstrate hot-jet simulation capabilities in cryogenic wind-tunnel testing, a series of experiments was conducted in the NAL 0.1 m Transonic Cryogenic Wind Tunnel. A cylindrical nozzle-afterbody model with a blunt base was used to evaluate the effects of jet temperature on the base pressure. Tests were carried out at Mach number of 0.8 and at three different stagnation temperatures of 100, 120, and 140 K. Temperature of a nitrogen jet gas was varied from 125 to 420 K to provide jet temperature ratio, values up to 4. The obtained data have verified that the absolute jet temperature is not essential for proper simulation of a hot jet. A comparison of the measured base pressure with hot-jet data by NACA with an ethylene/air combustor in an ambient-temperature tunnel showed a good qualitative agreement. Author

A92-26976#

PREDICTION OF THE PRESSURE LOSS COEFFICIENT OF WIND TUNNEL TURBULENCE REDUCING SCREENS

SEYMOUR SALMIRS and SAMER ALJABARI (Arizona State University, Tempe) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 8 p. refs

(AIAA PAPER 92-0568) Copyright

Numerical data from previous experiments are correlated, and compared to the results of wind-tunnel tests on three screens to develop an empirical equation for predicting the screen-pressure loss coefficient. Numerical data are taken from the investigations by Schubauer et al. (1949), Derbunovich et al. (1981), and Slamirs and Herrick (1990). Equations for coefficient prediction are developed based on screen-drag analysis, frequency measurements, and cylinder-drag analysis. For screens with a solidity of between 0.2 and 0.6 a standard deviation is calculated of about 10 percent at wire Reynolds numbers of not more than 600. The empirical equations can predict screen-pressure loss coefficients with good accuracy, and the empirical analysis can be applied to the efficient evaluation of screen turbulence-reduction effectiveness. C.C.S.

A92-27042#

GROUND FACILITY INTERFERENCE ON AIRCRAFT CONFIGURATIONS WITH SEPARATED FLOW

L. E. ERICSSON (Lockheed Missiles and Space Co., Inc., Sunnyvale, CA) and M. E. BEYERS (Institute for Aerospace Research, Ottawa, Canada) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 11 p. refs

(AIAA PAPER 92-0673) Copyright

Analysis of recent test results obtained on strut-mounted aircraft models have revealed significant test facility interference effects. In addition to dynamic support interference, coupling with unsteady wall interference effects can be present even when the model is relatively small in relation to the test section size. This coupled support/wall interference is expected to be more severe in pitch-oscillation than in roll-oscillation test. Significant interference of this type was identified in dynamic cross-coupling data obtained on the Standard Dynamics Model oscillating in pitch. The asymmetrical static rolling-moment characteristics measured on a 65-deg, delta wing are shown to be attributable to the effect of support interference on vortex breakdown. For the oscillating delta wing the support interference produces asymmetries in the measured normal force characteristics, which decrease with increasing roll rate. Author

A92-27102#

SUPERSONIC COMBUSTOR TESTING USING OPTICAL DIAGNOSTICS AND A HIGH ENTHALPY SHOCK TUNNEL

T. E. PARKER, M. G. ALLEN, W. G. REINECKE, H. H. LEGNER, R. R. FOUTTER, and W. T. RAWLINS (Physical Sciences, Inc., Andover, MA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 11 p. refs

(Contract F33615-88-C-2907)

(AIAA PAPER 92-0761) Copyright

The development of supersonic combusting ram jet engines requires testing using new, nonintrusive, instrumentation methods in high speed, high enthalpy flow facilities. The stagnation temperatures for very high flight speeds (in excess of 3000 K) make the production of these flows impossible using conventional methods can as resistance heaters or vitiated flows. Similarly, measurements of properties in these flows is difficult since the measurement must be nonintrusive in nature. This report describes a test series using a shock tunnel to produce Mach 3.0 flows with stagnation temperatures in excess of 3000 K and an optical diagnostic set specifically tailored for measurements in supersonic high temperature systems. The test facility includes a hydrogen injection capability which makes combustion tests possible for these flows. The paper describes the shock tunnel and its capabilities, provides an overview of the optical diagnostics used in the testing, and discusses the results of both combusting and noncombusting tests. Author

N92-18012# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

AN APPLICATION OF THE OBJECT-ORIENTED PARADIGM TO A FLIGHT SIMULATOR M.S. Thesis

DENNIS J. SIMPSON Dec. 1991 203 p

(AD-A243624; AFIT/GCS/ENG/91D-22) Avail: NTIS HC/MF A10 CSCL 12/5

This thesis describes the object-oriented software development techniques that were used to analyze, design and implement a flight simulator. The objective of this thesis was to present a comprehensive object-oriented software development methodology and show how it was used in constructing an actual application. An extensive review of current object-oriented practices is presented along with the methods that were used to take the flight simulator from analysis to design and through to implementation. The description of the methodology concentrates upon the design and implementation phases of the object-oriented software lifecycle. Examples from the design of the flight simulator demonstrate how each phase of the methodology was applied. The thesis includes insights on how to use the C++ language in implementing an object-oriented design and how to fold procedurally oriented code into an object-oriented framework. GRA

N92-18037# National Aerospace Lab., Tokyo (Japan). Computational Sciences Div.

ULTRA HIGH SPEED NUMERICAL WIND TUNNEL (UHSNWT) INITIATIVE AT NATIONAL AEROSPACE LABORATORY NUMERICAL SIMULATOR - SECOND GENERATION

HAJIME MIYOSHI May 1991 31 p In JAPANESE; ENGLISH summary

(NAL-TR-1108; ISSN-0389-4010) Avail: NTIS HC/MF A03

In order to promote computational fluid dynamics (CFD) research activities and effectively apply their results in the research and development of future aircraft and space planes, it is necessary to develop within the next two or three years a CFD-oriented computer (ultra high-speed numerical wind tunnel/UHSNWT) whose CFD processing speed is more than 100 times higher than the currently used Fujitsu VP400, and also to subsequently develop a computer more than 1000 times faster by the end of 1990's. The requirements for the UHSNWT are discussed from a perspective of development and operation costs, reliability, affinity with CFD programs, and operation environment. In addition, a National Aerospace Laboratory (NAL) UHSNWT initiative is proposed based on the following: (1) vector computer operational; (2) program processing software simulation for several vector

computer configurations; and (3) future trend forecasts of Large-Scale Integrated Circuit (LSI) technology. It is concluded that developing the UHSNWT with a performance of more than 100 times higher than the VP400 is feasible using a parallel computer having a distributed memory and crossbar network.
Author

N92-18069# Oak Ridge National Lab., TN.
ULTRA-HIGH TEMPERATURE (GREATER THAN 2000 C) TESTING CAPABILITY AT OAK RIDGE NATIONAL LABORATORY FOR CARBON MATERIALS IN AIR, INERT GAS AND VACUUM
R. L. HUDDLESTON and D. G. OCONNOR 1991 12 p Presented at the International Symposium on Ultra-High Temperature Materials, Jajimi City, Japan, 7 Dec. 1991
(Contract DE-AC05-84OR-21400)
(DE92-004445; CONF-911272-1) Avail: NTIS HC/MF A03
A new ultra-high temperature multiaxial (axial-torsional) test system concept is being developed for the testing of carbon-carbon composite materials at temperatures up to 2200 C in air, argon, and vacuum. The basic system concept incorporates computer control of temperature, pressure, and strain, displacement, or load versus time such that one can either test materials in the conventional monotonic or cyclic mode or 'fly a temperature-pressure-stress vs time profile' to simulate a vehicle trajectory from ground level to space or vice versa. A unique spherical hydrostatic bearing concept is being developed which should permit the system to transmit both axial and torsional loadings with low induced bending moments. The basic test system has been assembled and shakedown tests of ATJ graphite specimens have been conducted at temperatures up to 1910 C.
DOE

N92-18290# Sandia National Labs., Albuquerque, NM.
COMBINED VISAR AND FLASH X RAY TESTING TECHNIQUES
D. H. SANCHEZ, J. C. LANOUE, and G. A. LARE (Ktech Corp., Albuquerque, NM.) 1991 11 p Presented at the 16th Annual Joint Firing Set Conference, Livermore, CA, 15-17 Oct. 1991
(Contract DE-AC04-76DP-00789)
(DE92-004732; SAND-91-2376C; CONF-9110282-2-VUGRAPHS)
Avail: NTIS HC/MF A03
We have developed an experimental facility that provides simultaneous imaging of flyer plates with measurement of flyer velocity. This system allows us to test both explosive and electrically-driven flyers over a temperature range of -54 to +74 C. Our Velocity Interferometer System for Any Reflector (VISAR) is capable of measuring flyer velocities from 0.5 to 6 nm/microns. The flash x-ray system allows recording images of flyers with a minimum thickness of 0.05 mm and a minimum diameter of 0.002 inches.
DOE

N92-18341# Manchester Univ. (England). Aeronautical Engineering Group.
THE INSTALLATION OF THE AVRO 9 BY 7 FOOT LOW-SPEED WIND TUNNEL AT THE UNIVERSITY OF MANCHESTER (ENGLAND)
D. I. A. POLL 1990 16 p
(Contract GRF/58646)
(AERO-REPT-9005; ETN-92-90922) Avail: NTIS HC/MF A03
The acquisition of the low speed tunnel, a university based facility having potential for fundamental high Reynolds number research in fluid dynamics, is described. The basic layout and leading dimensions of the tunnel are shown. The tunnel is of the closed return type which means that the power consumption for a given test speed is low. The principal design features and quoted performance figures are given. The move to the Goldstein Aeronautical Engineering Laboratory (north west of Manchester) is described.
ESA

N92-18415# National Aerospace Lab., Amsterdam (Netherlands). Structures and Materials Div.
NLR EXPERIENCE WITH HIGH VELOCITY BURNER RIG TESTING, 1979-1989
R. J. H. WANHILL, A. J. A. MOM, H. J. C. HERSBACH, G. A. KOOL, and J. A. M. BOOGERS 28 Apr. 1989 33 p Submitted for publication
(NLR-TP-89152-U; ETN-92-90958) Avail: NTIS HC/MF A03
A large, custom built rig was commissioned in 1977 to enable actual components to be tested. A smaller rig for specimen testing was purchased in 1986. Experience of two high velocity burner rigs for oxidation and hot corrosion testing over the last decade is reviewed.
ESA

N92-18416# National Aerospace Lab., Amsterdam (Netherlands). Fluid Dynamics Div.
MODEL INCIDENCE MEASUREMENT USING SAAB ELOPTOPOS SYSTEM
P. H. FUYKSCHOT 23 May 1989 8 p Presented at the 13th International Congress on Instrumentation in Aerospace Simulation Facilities, Goetigen, Fed. Republic of Germany, 18-21 Sep. 1989
(NLR-TP-89182-U; ETN-92-90959) Avail: NTIS HC/MF A02
For measuring the angle of attack of models in a transonic windtunnel, a SAAB ELOPTOPOS system was acquired. The system consists of two infrared Light Emitting Diodes (LEDs) mounted fore and aft in the fuselage of the model, two linear array Charged Coupled Device (CCD) cameras, and special processors. The cameras are mounted to the sidewall of the windtunnel and have a viewing angle of 60 deg in the vertical direction. Thanks to a special optimizing algorithm, the camera resolution is enhanced to 0.001 deg. At a viewing distance of one meter, the resulting resolution in angle of attack of the model is typically 0.0026 deg. The system is individually calibrated for each mode under wind off conditions, using an extremely accurate gravity sensing inclinometer as a reference. This procedure ensures the required accuracy of 0.01 deg in angle of attack under wind on conditions.
ESA

N92-18956*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A USER'S GUIDE TO THE LANGLEY 16- BY 24-INCH WATER TUNNEL
ODIS C. PENDERGRAFT, JR., DAN H. NEUHART, and TIMMY T. KARIYA (Vigyan Research Associates, Inc., Hampton, VA.) Jan. 1992 127 p
(NASA-TM-104200; NAS 1.15:104200) Avail: NTIS HC/MF A07 CSCL 14/2
The Langley 16 x 24 inch Water Tunnel is described in detail, along with all the supporting equipment used in its operation as a flow visualization test facility. These include the laser and incandescent lighting systems; and the photographic, video, and laser fluorescence anemometer systems used to make permanent records of the test results. This facility is a closed return water tunnel capable of test section velocities from 0 to 0.75 feet per second with flow through the 16 x 24 inch test section in a downward (vertical) direction. The velocity normally used for testing is 0.25 feet per second where the most uniform flow occurs, and is slow enough to easily observe flow phenomena such as vortex flow with the unaided eye. An overview is given of the operational characteristics, procedures, and capabilities of the water tunnel to potential users of the facility so that they may determine if the facility meets their needs for a planned study.
Author

N92-19218*# MCAT Inst., San Jose, CA.
STUDY OF OPTICAL TECHNIQUES FOR THE AMES UNITARY WIND TUNNELS. PART 1: SCHLIEREN Progress Report
GEORGE LEE Feb. 1992 32 p
(Contract NCC2-716)
(NASA-CR-189951; NAS 1.26:189951; REPT-92-002) Avail: NTIS HC/MF A03 CSCL 14/2
Alignment procedures and conceptual designs for the rapid alignment of the Ames Unitary Wind Tunnel schlieren systems were devised. The schlieren systems can be aligned by translating

the light source, the mirrors, and the knife edge equal distances. One design for rapid alignment consists of a manual pin locking scheme. The other is a motorized electronic position scheme. A study of two optical concepts which can be used with the schlieren system was made. These are the 'point diffraction interferometers' and the 'focus schlieren'. Effects of vibrations were studied.
Author

N92-19642# Simtec, Inc., Manassas, VA.
SIMULATOR DATA INTEGRITY PROGRAM: PROCESS STANDARD DEVELOPMENT Final Report, 5 Dec. 1988 - 5 Apr. 1991
JOB J. SHAW and STEPHEN MUSSELMAN 5 Apr. 1991 36 p
(Contract F33657-88-C-2168)
(AD-A242207; SIMTEC/TR-91-01; ASD-TR-91-5011) Avail: NTIS HC/MF A03 CSCL 05/6

The Simulator Integrity Program is a component of the overall Air Force initiatives to improve the quality, performance, scheduling and supportability of Aircrew Training Equipment. This program focuses on the quality, timeliness, currency, and maintenance of the technical information (source data) generated in the weapon system organizations and used in the training equipment development and support organizations. In accordance with the Statement of Work for the Simulator Data Integrity Program this report documents the methodology, findings, accomplishments, conclusions and recommendations associated with the development, review, and introduction of the principal product of this effort, Military Standard-Aircrew Training Equipment Source Data Process Standard MIL-STD-XXXX, October 1990. A general description of the overall effort is provided in Appendix 1. GRA

N92-19675*# California Univ., Berkeley. Dept. of Electrical Engineering and Computer Sciences.
A WALK THROUGH THE PLANNED CS BUILDING M.S. Thesis
DELNAZ KHORRAMABADI Oct. 1991 73 p
(Contract NAG2-591)
(NASA-CR-189963; NAS 1.26:189963; UCB/CSD-91/652) Avail: NTIS HC/MF A04 CSCL 14/2

Using the architectural plan views of our future computer science building as test objects, we have completed the first stage of a Building walkthrough system. The inputs to our system are AutoCAD files. An AutoCAD converter translates the geometrical information in these files into a format suitable for 3D rendering. Major model errors, such as incorrect polygon intersections and random face orientations, are detected and fixed automatically. Interactive viewing and editing tools are provided to view the results, to modify and clean the model and to change surface attributes. Our display system provides a simple-to-use user interface for interactive exploration of buildings. Using only the mouse buttons, the user can move inside and outside the building and change floors. Several viewing and rendering options are provided, such as restricting the viewing frustum, avoiding wall collisions, and selecting different rendering algorithms. A plan view of the current floor, with the position of the eye point and viewing direction on it, is displayed at all times. The scene illumination can be manipulated, by interactively controlling intensity values for 5 light sources.
Author

N92-19940# Sydney Univ. (Australia). School of Civil and Mining Engineering.
DEVELOPMENT OF A WIND CHAMBER FOR MODEL TESTING OF TORNADO FORCES ON STRUCTURES
R. D. WATKINS and D. L. BENEKE May 1991 23 p
(PB92-104165; R-638) Avail: NTIS HC/MF A03 CSCL 14/2

The aim of the study was to investigate the possibility of modeling the most significant features of volcanoes with respect to their effects at near-ground level. Tornadoes are typically local vortex-type phenomena with high-speed rotating cores. Due to their unpredictability, there is a lack of data on the loadings they can impose on structures, and hence it is desirable to provide a convenient and controllable model testing system for such cases. After trying a number of possible arrangements, a satisfactory system has evolved, which is essentially a closed cylindrical chamber that has fluid movement initiated and maintained by a drive unit in its upper part, thereby leaving the lower part free for ground and structural modeling.
Author

N92-19978# Sandia National Labs., Albuquerque, NM.
PRESSURE MEASUREMENTS IN HIGH SPEED WATER TUNNELS
E. L. CLARK 1992 10 p Proposed for presentation at the 38th International Instrumentation Symposium, Las Vegas, NV, 26-30 Apr. 1992
(Contract DE-AC04-76DP-00789)
(DE92-004891; SAND-91-2851C; CONF-920460-1) Avail: NTIS HC/MF A02

The measurement of surface pressures on a body which is submerged in flowing water involves several problems which are not encountered when the test medium is air. Many of these problems exist even if the water velocity is low, and become more severe at higher velocities (45 to 65 ft/sec) where the surface pressure may be low enough for cavitation to occur. Problem areas which are discussed include: (1) hydrostatic pressure, (2) surface tension, (3) orifice errors, (4) thermal effects on surface-mounted transducers, (5) electrical fields, and (6) two-phase phenomena. DOE

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ASTRONAUTICS

Includes astronautics (general); astrodynamics; ground support systems and facilities (space); launch vehicles and space vehicles; space transportation; spacecraft communications, command and tracking; spacecraft design, testing and performance; spacecraft instrumentation; and spacecraft propulsion and power.

A92-24668* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
STRUCTURAL DESIGN CONSIDERATIONS FOR A PERSONNEL LAUNCH SYSTEM
LANCE B. BUSH, CHRISTOPHER A. LENTZ (NASA, Langley Research Center, Hampton, VA), JAMES C. ROBINSON (Old Dominion University Research Foundation, Norfolk, VA), and IAN O. MACCONOCHIE (Lockheed Engineering and Sciences Co., Hampton, VA) Journal of Spacecraft and Rockets (ISSN 0022-4650), vol. 29, Jan.-Feb. 1992, p. 138-149. Previously cited in issue 11, p. 1624, Accession no. A90-29280. refs
Copyright

A92-24780 National Aeronautics and Space Administration, Washington, DC.
FIBER OPTICS FOR THE NATIONAL AERO-SPACE PLANE
PETER J. ERBLAND (National Aero-Space Plane Joint Program Office, Wright-Patterson AFB, OH) IN: Fiber optic smart structures and skins III; Proceedings of the Meeting, San Jose, CA, Sept. 19-21, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 29-44. refs
Copyright

An evaluation is made of NASP vehicle features which bear on the need for, and the feasibility of, incorporating fiber-optic structural-state diagnostic sensors. The most likely application appears to be fiber-optic data links for high-bandwidth communications; this is followed in order of diminishing likelihood by distributed sensing systems, advanced optical transduction techniques, fiber-optic microphones, and nonintrusive measurements of flowfield density. Specific fiber-optic sensors will be employed where they are overwhelmingly favored by a cost-benefit analysis. O.C.

A92-24910
HOPE LOOKS TO CFD FOR HELP
YUKIMITSU YAMAMOTO, SATORU OGAWA, and SUSUMU

TAKANASHI (National Aerospace Laboratory, Tokyo, Japan) Aerospace America (ISSN 0740-722X), vol. 30, Feb. 1992, p. 39-41.
Copyright

The Japanese National Aerospace Laboratory's H-II Orbiting Plane ('HOPE'), currently under development, makes intensive use of CFD techniques in virtue of the impossibility of simulating real-gas effects with ground-based hypersonic experimental facilities. CFD can calculate the complete hypersonic real-gas flowfield around HOPE via chemically nonequilibrium Navier-Stokes codes, with all due attention to air dissociation and ionization over the entire vehicular surface. O.C.

A92-25503
ON THE SKIP FLIGHT OF A SPACEPLANE
MASATO KUDO and KANICHIRO KATO Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 39, no. 455, 1991, p. 662-665. In Japanese. refs

Optimal paths are shown when a spaceplane skips in the uppermost atmosphere. The flight-path is optimized to give maximum terminal velocity. Typical numerical results show that the range could be doubled with one jump with the sacrifice of 15 percent of the initial velocity. Author

A92-25756#
A HYPERSONIC WAVERIDER TEST VEHICLE - THE LOGICAL NEXT STEP
D. J. TINCHER (Science Applications International Corp., Huntsville, AL) and D. W. BURNETT (McDonnell Douglas Corp., Huntington Beach, CA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 11 p. refs
(AIAA PAPER 92-0308) Copyright

The present status of hypersonic waverider technology is addressed. The need for hypersonic waveriders and the reality of current waveriders and their attributes are described. The development of a waverider flight test vehicle and anticipated experimentation are discussed. C.D.

A92-27107#
EFFECT OF CARBON PARTICLES AND MIXING ON AFTERBURNING OF EXHAUST PLUMES
K. J. KRAEUTLE, K. J. WILSON, M. J. LEE, K. H. YU, E. GUTMARK, and K. C. SCHADOW (U.S. Navy, Naval Air Warfare Center, China Lake, CA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 10 p. refs
(AIAA PAPER 92-0767)

The effect of temperature, equivalence ratio, coaxial air flow, and the concentration and particle size of carbon particles on the afterburning behavior of exhaust plumes was investigated. The exhaust plume was produced by the flow of hot combustion gases through a circular nozzle at Mach 2. The carbon was added to the gases in the combustion chamber. A thermal imaging camera and three phototransistors were used to observe the plume from the nozzle to approximately 1.2 m downstream. The results show the response of afterburning and plume radiation to changes in mixing with air, temperature, equivalence ratio, size, and concentration of carbon particles. Decreasing chamber temperature and equivalence ratio and increasing mixing with ambient air decreased afterburning and plume radiation. Carbon particles increased the plume radiation. The increase was higher for fine than for coarse carbon. Author

N92-18280*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A SURVEY OF INSTABILITIES WITHIN CENTRIFUGAL PUMPS AND CONCEPTS FOR IMPROVING THE FLOW RANGE OF PUMPS IN ROCKET ENGINES
JOSEPH P. VERES Feb. 1992 17 p Proposed for presentation at the 1992 JANNAF Propulsion Meeting, Indianapolis, IN, 24-28 1992
(NASA-TM-105439; E-6859; NAS 1.15:105439) Avail: NTIS HC/MF A03 CSCL 21/8

Design features and concepts that have primary influence on the stable operating flow range of propellant-feed centrifugal turbopumps in a rocket engine are discussed. One of the throttling limitations of a pump-fed rocket engine is the stable operating range of the pump. Several varieties of pump hydraulic instabilities are mentioned. Some pump design criteria are summarized and a qualitative correlation of key parameters to pump stall and surge are referenced. Some of the design criteria were taken from the literature on high pressure ratio centrifugal compressors. Therefore, these have yet to be validated for extending the stable operating flow range of high-head pumps. Casing treatment devices, dynamic fluid-damping plenums, backflow-stabilizing vanes and flow-reinjection techniques are summarized. A planned program was undertaken at LeRC to validate these concepts. Technologies developed by this program will be available for the design of turbopumps for advanced space rocket engines for use by NASA in future space missions where throttling is essential. Author

N92-18942# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
THRUST VECTOR CONTROL OF AN OVEREXPANDED SUPERSONIC NOZZLE USING PIN INSERTION AND ROTATING AIRFOILS M.S. Thesis
CURTIS R. AMBLE Dec. 1991 102 p
(AD-A243891) Avail: NTIS HC/MF A06 CSCL 21/8

An experimental study of probe thrust vector control of overexpanded supersonic flow in nozzles using movable probes as the vectoring mechanism is presented. Two types of movable probes were used. The first inserted cylindrical probes through the wall of the nozzle to set depths relative to the nozzle wall; the second used rotating airfoils, inserted within the nozzle flow, rotated to various angles of attack relative to the nozzle centerline. Effectiveness of these probe thrust vector control mechanisms was investigated for a confined jet and conical nozzle. The study objective was to evaluate performance and transient characteristics of these probe thrust vector control mechanisms. Data are presented for both a confined jet nozzle and conical nozzle operating with primary stagnation pressures ranging from 150 psia to 460 psia and exhausting to atmospheric pressure. The range in pressure above 150 psia represents the region where flow in both configurations is stable and supersonic in axial operation. Limitations in the pressure supply allowed evaluation of both configurations only in the overexpanded flow regime. Axial force, lateral force, and static nozzle wall pressure distribution data were measured for axial and vectored operation for each nozzle configuration. Test results showed that probe thrust vector control using cylindrical pin insertion is a viable thrust vectoring mechanism. Performance of the cylindrical pins was repeatable in both nozzle configurations. GRA

N92-19934*# Akron Univ., OH.
A HIERARCHY FOR MODELING HIGH SPEED PROPULSION SYSTEMS Final Report
TOM T. HARTLEY and ALEX DEABREU Dec. 1991 20 p
(Contract NAG3-904)
(NASA-CR-186984; NAS 1.26:186984) Avail: NTIS HC/MF A03 CSCL 21/8

General research efforts on reduced order propulsion models for control systems design are overviewed. Methods for modeling high speed propulsion systems are discussed including internal flow propulsion systems that do not contain rotating machinery, such as inlets, ramjets, and scramjets. The discussion is separated into four areas: (1) computational fluid dynamics models for the entire nonlinear system or high order nonlinear models; (2) high order linearized models derived from fundamental physics; (3) low order linear models obtained from the other high order models; and (4) low order nonlinear models (order here refers to the number of dynamic states). Included in the discussion are any special considerations based on the relevant control system designs. The methods discussed are for the quasi-one-dimensional Euler equations of gasdynamic flow. The essential nonlinear features represented are large amplitude nonlinear waves, including moving normal shocks, hammershocks, simple subsonic combustion via

heat addition, temperature dependent gases, detonations, and thermal choking. The report also contains a comprehensive list of papers and theses generated by this grant. H.A.

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CHEMISTRY AND MATERIALS

Includes chemistry and materials (general); composite materials; inorganic and physical chemistry; metallic materials; nonmetallic materials; and propellants and fuels.

A92-24744
THE JET SCREEN IGNITION SCHEME AND ITS EXPERIMENTAL VERIFICATION
QUN YIN (Shenyang Aeroengine Research Institute, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, Jan. 1992, p. 69-71. In Chinese.

A jet screen ignition scheme has been developed based on the investigation of the ignition environment of the burning zone in the high-speed flow combustor. It features a short-time change of the flow pattern in the high-speed flow near the wall during the ignition period which is caused by a thin and bend high speed gas jet. A specially-designed ignition experiment on a model of an aerogasturbine combustor verified success of the proposed scheme and showed its potentiality in enlarging the ignition range of the high-speed flow combustor. Author

A92-24831
INCLUSION SIZE EFFECT ON THE FATIGUE CRACK PROPAGATION MECHANISM AND FRACTURE MECHANICS OF A SUPERALLOY
TAKESHI DENDA (Nippon Mining Co., Tokyo, Japan), PETER L. BRETZ, and JOHN K. TIEN (Texas, University, Austin) Metallurgical Transactions A - Physical Metallurgy and Materials Science (ISSN 0360-2133), vol. 23A, Feb. 1992, p. 519-526. refs
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Low cycle fatigue life of nickel-base superalloys is enhanced as a consequence of inclusion reduction in the melt process; however, the functional dependencies between fatigue characteristics and inclusions have not been well investigated. In this study, the propagation mechanism of the fatigue crack initiated from inclusions is examined in fine-grained IN718, which is a representative turbine disk material for jet engines. There is a faceted-striated crack transition on the fracture surfaces. This faceted-striated transition also appears in the da/dN vs crack length curves. It is observed that the faceted crack propagation time can be more than 50 pct of total lifetime in the low cycle fatigue test. The significance of inclusion size effect is explained on the premise that the faceted fatigue crack propagation time scales with the inclusion size, which is taken as the initial crack length. A predictive protocol for determining inclusion size effect is given. Author

A92-25031
CREEP FRACTURE MECHANISMS IN SINGLE CRYSTAL SUPERALLOYS
S. H. AI (Chinese Academy of Sciences, Institute of Metal Research, Shenyang, People's Republic of China), V. LUPINC, and M. MALDINI (CNR, Istituto per la Tecnologia dei Materiali Metallici non Tradizionali, Cinisello Balsamo, Italy) Scripta Metallurgica et Materialia (ISSN 0956-716X), vol. 26, Feb. 15, 1992, p. 579-584. Research supported by International Centre for Theoretical Physics. refs
Copyright

Results of a study of creep fracture mechanisms in single-crystal Ni-based superalloys, CMSX-2, SRR 99, and RR2000, are reported. It is found that creep cracks always initiate at casting pores and also at carbides in alloys containing a higher carbon level. Cracks propagate anisotropically along the (001) crystallographic planes perpendicular to the applied load, preferably along the gamma/gamma prime interfaces. The creep crack damage mechanisms are found to be independent of the test temperature and stress. V.L.

A92-25787# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
A NUMERICAL INVESTIGATION OF HYDROGEN COMBUSTION IN MACH 2 FLOW
CORIN SEGAL, HOSSEIN HAJ-HARIRI, and JAMES C. MCDANIEL (Virginia, University, Charlottesville) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 17 p. Research supported by NASA. refs
(Contract NAG1-795)
(AIAA PAPER 92-0341) Copyright

A numerical study is conducted of a reacting flowfield generated by a single hydrogen jet injected transversely behind a rearward facing step. A nonreacting mixing study was followed by a reacting simulation. The computation simulates a current experimental condition. The validation of the numerical solution was limited to a comparison of the wall-pressure distribution along the wall. The comparison indicates agreement between the experiment and the prediction with a maximum error of 7 percent. The addition of the reaction responsible for HO2 production (H + O2 + M = HO2 + M) to an initially simplified chemical mechanism reduced the exponential growth of the free radicals and reduced the amount of heat released by combustion; as a result, the flowfield was significantly changed. A reversed flow was obtained in limited regions of the flow. Author

A92-25997
AN EXPERIMENTAL STUDY OF SUPERSONIC H2 COMBUSTION AND HEAT TRANSFER IN A CIRCULAR DUCT [EKSPERIMENTAL'NOE ISSLEDOVANIE GORENIIA H2 I TEPLOOTVODA V KOL'TSEVOM KANALE PRI SVERKHZVUKOVOI SKOROSTI]
R. V. ALBEGOV, V. A. VINOGRADOV, G. G. ZHADAN, and S. A. KOBYZHSKII Fizika Goreniia i Vzryva (ISSN 0430-6228), vol. 27, Nov.-Dec. 1991, p. 24-29. In Russian. refs
Copyright

Results of an experimental study of supersonic H2 combustion and heat transfer in a circular duct simulating the intake and the combustion chamber of a ramjet engine are reported. Stable operation regions for the intake and the combustion chamber are determined for various fuel distributions. The level of heat transfer to the duct walls and combustion efficiency are calculated as a function of the varying flow in the duct. V.L.

A92-26152
PROCESSING EFFECTS AND DAMAGE TOLERANCE IN POLY(ETHERETHERKETONE) COMPOSITES
F. S. URALIL, G. M. NEWAZ (Battelle, Columbus, OH), and A. LUSTIGER (AT&T Bell Laboratories, Murray Hill, NJ) Polymer Composites (ISSN 0272-8397), vol. 13, Feb. 1992, p. 7-14. refs
Copyright

Ultrasonic C-scan and compression-after-impact testing are implemented on PEEK APC-2 plaques cooled at three different cooling rates, in addition to toughened epoxy and bismaleimide plaques processed conventionally as a comparison. It is seen that the damaged areas as measured ultrasonically varied significantly between the PEEK samples cooled at different rates. Under the slowest cooling conditions, the damaged areas approached those of the thermosetting systems tested. R.E.P.

A92-26351
MECHANICAL TESTING OF GLASS-CERAMIC MATRIX COMPOSITES
T. GRENIER (ONERA, Chatillon, France), G. BESSENAY (SNECMA, Evry, France), M. PARLIER, and M. H. RITTY (ONERA, Chatillon, France) (International Symposium on Ceramic Materials and Components for Engines, 4th, Goteborg, Sweden, June 10-12, 1991) ONERA, TP no. 1991-182, 1991, 12 p. Research supported

by DRET and Service Technique des Programmes Aeronautiques. refs
(ONERA, TP NO. 1991-182)
The utility of composites based on glass-ceramic matrices is investigated with respect to their application in turbine engines and enhancing the composites' long-term resistances. A lithium almuminum silicate (LAS) matrix reinforced with Nicalon SiC fibers is examined by means of microstructural analysis and mechanical testing under high-temperature conditions. The crystallization and interface structures are described and illustrated, and the mechanical tests include three-point bending and tensile strength. The LAS/SiC material properties at temperatures of up to 900 C compare favorably with those of 2D composites. Two classes of application are identified for the materials: small complex parts with multiaxial stress fields, and large axisymmetrical parts with simpler stress fields. The cost-effectiveness of manufacturing the parts combined with good mechanical properties suggest that the LAS/SiC composites are suitable for the exhaust-system components of aerospace engines. C.C.S.

A92-26667
A FATIGUE CRACK GROWTH THRESHOLD
G. MARCI (DLR, Institut fuer Werkstoff-Forschung, Cologne, Federal Republic of Germany) Engineering Fracture Mechanics (ISSN 0013-7944), vol. 41, Feb. 1992, p. 367-385. refs
Copyright
The transferability of experimentally determined fatigue crack growth (FCG) threshold to the service-type fatigue loading was demonstrated using FCG threshold value determined for Ti6Al4V, Al 7475-T7351, and quenched and tempered steel 24CrMo4, as well as for the Ni-base alloys Inconel 617 and Nicrofer 5219 Nb. It is shown that the requirements that must be met in order to ensure transferability are met in all the experimental procedures: type I, III, and IV tests all furnished Delta K(T) values for Al 7475-T7351, Ti6Al4V, and the quenched and tempered steel 24CrMo4. Therefore, any one test method can be used to determine Delta K(T) for these materials. For the Ni-base alloys, however, only type III and IV tests can be used to determine a FCG threshold Delta K(T), due to the different behavior of Ni-base alloys with respect to the stress-intensity factor at which a fatigue crack opens, K(op). I.S.

A92-26850
IMPROVING SAMPLE INTRODUCTION FOR TOTAL WEAR METAL DETERMINATION BY ATOMIC EMISSION SPECTROSCOPY
COSTANDY S. SABA and RITA J. BYRD (Dayton, University, OH) (STLE, Annual Meeting, 45th, Denver, CO, May 7-10, 1990) Lubrication Engineering (ISSN 0024-7154), vol. 48, March 1992, p. 227-232. refs
(Contract F33615-88-C-2817)
Copyright
The sample introduction system of an ac spark atomic emission spectrometer was modified to improve the detection of wear metal with particles greater than one to three microns. The rotating disc electrode parameters, which include preburn time, exposure time, electrode gap setting, spark intensity, gas flow, and updraft pressure of exhaust, were optimized using the modified electrode geometry and surface density. A reliable ashing technique based on a residue tester with operator-selectable temperature ramping and gas flows was developed to improve repeatability and accuracy. The use of a collimating lens installed in the optical path between the analytical gap and the entrance slit to condense the light reaching the entrance slit proved to be effective in improving signal repeatability. The improved capability of the ashing technique in detecting wear relative to the traditional rotating disc method is illustrated by comparative data. O.G.

A92-27050#
HIGH TEMPERATURE, THERMALLY STABLE JP FUELS - AN OVERVIEW
T. EDWARDS, S. D. ANDERSON, J. A. PEARCE, and W. E. HARRISON, III (USAF, Wright Laboratory, Wright-Patterson AFB, OH) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 11 p. Research supported by USAF. refs
(AIAA PAPER 92-0683)
A program for developing high temperature thermally stable (HiTTS) fuels is reviewed. The HiTTS 100 (JP-8+100) program is an empirically based experimental program aimed at developing an additive package to increase the thermal stability of JP-8 from 163 C to 218 C and increase the available heat sink by 50 percent. Particular attention is given to test methods for measuring the fuel stability. Test strategies range from simple single-tube heat exchanger experiments to the testing of the fuel/additive package in a reduced-scale aircraft simulator. O.G.

A92-27051#
HIGH DENSITY FUEL QUALIFICATION FOR A GAS TURBINE ENGINE
J. D. MACLEOD (National Research Council of Canada, Ottawa), B. ORBANSKI (Standard Aero, Ltd., Winnipeg, Canada), and P. R. HASTINGS (DND, Ottawa, Canada) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 11 p. refs
(AIAA PAPER 92-0684) Copyright
A program for the evaluation of gas turbine engine performance, carried out in the Engine Laboratory of the National Research Council of Canada, is described. Problems under consideration include performance alteration between JP-4 fuel and a high energy density fuel, called strategic military fuel (SMF); performance deterioration during the accelerated endurance test; and emission analysis. The T56 fuel control system is found to be capable of operation on the higher energy density fuel with no detrimental effects regarding control of the engine's normal operating regime. The deterioration of the engine performance during 150-hour endurance tests on SMF was very high, which was caused by an increase in turbine nozzle effective flow area and turbine blade untwist. The most significant performance losses during the endurance tests were on corrected output power, fuel flow, specific fuel consumption and compressor and turbine presure ratio. O.G.

A92-27052#
EXPERIMENTAL TECHNIQUES FOR THE ASSESSMENT OF FUEL THERMAL STABILITY
J. S. CHIN and A. H. LEFEBVRE (Purdue University, West Lafayette, IN) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 6 p. refs
(AIAA PAPER 92-0685) Copyright
Two different methods for characterizing the thermal oxidative tendencies of aviation fuels have been developed. A common feature of both methods is that the fuel under test is passed through a heated tube which is maintained at constant temperature throughout the test duration. One is a closed-loop system in which the fuel is recirculated continuously for periods up to 22 hours. The other is a single-pass device whereby the test fuel flows only once through the heated tube. These two methods and their relative merits are discussed in some detail, and the extent to which they simulate an actual aircraft fuel system is assessed alongside that of a more established test technique which maintains a constant heat flux through the tube wall and allows the wall temperature to increase continuously throughout the test duration. Author

A92-27053#
STATIC TESTS FOR THE EVALUATION OF FUEL ADDITIVES
SHAWN P. HENEGHAN (Dayton, University, OH), STACY L. LOCKLEAR, DAVID L. GEIGER, STEVEN D. ANDERSON (USAF, Wright Laboratory, Wright-Patterson AFB, OH), and WILLIAM D. SCHULTZ (Eastern Kentucky University, Richmond, KY) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 9 p. refs
(Contract F33615-87-C-2767)
(AIAA PAPER 92-0686) Copyright
A study aimed at the evaluation of jet fuel stability and the products of jet fuel breakdown using spectroscopic techniques is presented. Fourier transform infrared (FTIR) techniques have been developed to quantify the amount of alcohol and ketone species

in surrogate fuels. Gas chromatography with atomic emission detection (GCAED) is used to follow the production/consumption of oxygen/sulfur containing molecules. Multielemental analysis is used to study the elemental makeup of the deposits. Results of static tests indicate that there is good agreement between static and flowing tests concerning the quality of a fuel. Arbitrarily increasing the oxygen availability is likely to yield results which are not applicable to oxygen starved stressing processes. No direct relation is found beween the amount of oxidized products dissolved in a stressed fuel and the amount of insoluble solids formed.
O.G.

A92-27054#
DEPOSITION DURING VAPORIZATION OF JET FUEL IN A HEATED TUBE
TIM EDWARDS (USAF, Wright Laboratory, Wright-Patterson AFB, OH) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 13 p. refs
(AIAA PAPER 92-0687)

During fuel vaporization at low flow rates in a heated stainless steel tube, it was found that deposition is concentrated in the region of the tube where the fuel changes phase. The amount of deposition and the dissolved oxygen dependence of the deposition varied dramatically among the fuels tested. The amount of deposition generally correlated with Jet Fuel Thermal Oxidation Tester thermal stability rankings. Tests with varying residence times, temperatures, and pressures demonstrated that the deposition during vaporization is controlled by liquid phase thermal degradation reactions.
Author

A92-28251
ADVANCED MATERIALS FOR AIRCRAFT ENGINE APPLICATIONS
DANIEL G. BACKMAN (GE Aircraft Engines, Lynn, MA) and JAMES C. WILLIAMS (GE Aircraft Engines, Cincinnati, OH) Science (ISSN 0036-8075), vol. 255, Feb. 28, 1992, p. 1082-1087. refs
Copyright

Enhancements in aircraft gas turbine performance have been paced by the development of improved materials and processing technologies for turbine blades and disks; the blades are produced via investment casting. Attention is given to enhanced gamma-prime volume fraction Ni-base superalloys, their directional solidification, and the effects of thermal-barrier ceramic coatings. Turbine disk development has concentrated on the creation of low-cycle fatigue superalloys via improved powder-metallurgy processing, isothermal forging, and billet spray-forming. Producers are striving to incorporate intelligent processing, total quality management, and concurrent engineering.
O.C.

A92-28433
NUMERICAL SIMULATION OF INTERACTION OF DIFFUSION FLAME WITH VORTEX PAIR IN A RECIRCULATION ZONE
CHUANJUN YAN (Northwestern Polytechnical University, Xian, People's Republic of China) Journal of Propulsion Technology (ISSN 1001-4055), Aug. 1991, p. 49-56. In Chinese. refs

An examination is conducted of the structure of a diffusion flame in flow fields with vortex pairs, giving attention to the effect of flame diffusion on flow fields. The numerical results obtained exhibit excellent agreement with the analytical solution for the flame structure, when the effect of heat release due to chemical reaction and the change of density are ignored.
O.C.

A92-28503
FLAME SHEET ALGORITHM FOR USE IN NUMERICAL MODELING OF RAMJET COMBUSTION INSTABILITY
LUC BAUWENS (California, University, Berkeley) and JOHN W. DAILY (Colorado, University, Boulder) Journal of Propulsion and Power (ISSN 0748-4658), vol. 8, Mar.-Apr. 1992, p. 264-270. Research supported by Cray Research, Inc. Previously cited in issue 06, p. 789, Accession no. A90-19966. refs
(Contract N00014-84-K-0372)
Copyright

N92-18577# Industrieanlagen-Betriebsgesellschaft m.b.H., Ottobrunn (Germany, F.R.).
FATIGUE LIFE BEHAVIOUR OF COMPOSITE STRUCTURES
W. BROECKER and K. WOITHE *In* AGARD, Fatigue Management 10 p Dec. 1991
Copyright Avail: NTIS HC/MF A12; Non-NATO Nationals requests *available only from AGARD/Scientific Publications Executive*

The general fatigue behavior of composite structures is presented. The verification and certification philosophy, depending on the special behavior of the material, is shown. On this basis a lot of structure tests were carried out, taking test parameters such as damages, environmental influence, and load conditions into consideration. The summary of these tests is presented. Author

N92-19290*# Lockheed Aeronautical Systems Co., Marietta, GA. Research, Technology and Engineering Div.
DEVELOPMENT AND CHARACTERIZATION OF POWDER METALLURGY (PM) 2XXX SERIES AL ALLOY PRODUCTS AND METAL MATRIX COMPOSITE (MMC) 2XXX AL/SIC MATERIALS FOR HIGH TEMPERATURE AIRCRAFT STRUCTURAL APPLICATIONS Final Report
D. J. CHELLMAN, T. B. GURGANUS, and J. A. WALKER Feb. 1992 87 p
(Contract NAS1-16048)
(NASA-CR-187631; NAS 1.26:187631; LG92ER0022) Avail: NTIS HC/MF A05 CSCL 11/6

The results of a series of material studies performed by the Lockheed Aeronautical Systems Company over the time period from 1980 to 1991 are discussed. The technical objective of these evaluations was to develop and characterize advanced aluminum alloy materials with temperature capabilities extending to 350 F. An overview is given of the first five alloy development efforts under this contract. Prior work conducted during the first five modifications of the alloy development program are listed. Recent developments based on the addition of high Zr levels to an optimum Al-Cu-Mg alloy composition by powder metallurgy processing are discussed. Both reinforced and SiC or B4C ceramic reinforced alloys were explored to achieve specific target goals for high temperature aluminum alloy applications.
Author

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ENGINEERING

Includes engineering (general); communications; electronics and electrical engineering; fluid mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.

A92-24430
MEASUREMENT OF CONVECTIVE HEAT-TRANSFER COEFFICIENTS IN WIND TUNNELS USING PASSIVE AND STIMULATED INFRARED THERMOGRAPHY
D. L. BALAGEAS, D. M. BOSCHER, A. A. DEOM, J. FOURNIER, and G. GARDETTE (ONERA, Chatillon, France) La Recherche Aerospatiale (English Edition) (ISSN 0379-380X), no. 4, 1991, p. 51-72. Research supported by DRET. refs
Copyright

Infrared thermography is a means of visualization in common use now among workers in aerodynamics. Progress in infrared scanner technology makes it possible to determine transient surface-temperature distributions on wind tunnel models with good precision. By combining this technique with heat transfer analysis and modeling, the heat transfer coefficient distribution can be determined quantitatively. Two different ways are presented here for measuring the heat transfer coefficient using IRT: passive and active (or stimulated) thermography. A practical application of the two techniques is presented which concerns a missile model in a

supersonic wind tunnel. Comparisons are made between passive and active measurements, and between experiment and theory.
Author

A92-24553
FABRY-PEROT FIBER-OPTIC SENSORS IN FULL-SCALE FATIGUE TESTING ON AN F-15 AIRCRAFT
KENT A. MURPHY, MICHAEL F. GUNTHER, ASHISH M. VENGSARKAR, and RICHARD O. CLAUS (Virginia Polytechnic Institute and State University, Blacksburg) Applied Optics (ISSN 0003-6935), vol. 31, Feb. 1, 1992, p. 431-433. Research supported by Virginia Center for Innovative Technology. refs
Copyright

Results are reported from fiber-optic sensor field tests on an F-15 aircraft mounted within a full-scale test frame for the purpose of fatigue testing. Strain sensitivities of the order of 0.01 micron/m are obtained. Author

A92-24717* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A VISCOPLASTIC MODEL FOR SINGLE CRYSTALS
E. H. JORDAN (Connecticut, University, Storrs) and K. P. WALKER (Engineering Science Software, Inc., Smithfield, RI) ASME, Transactions, Journal of Engineering Materials and Technology (ISSN 0094-4289), vol. 114, Jan. 1992, p. 19-26. refs
(Contract NAG3-512; DE-AC02-88ER-13895)
Copyright

A viscoplastic constitutive model is described in which deformation behavior is postulated on representative slip systems and the behavior of the entire crystal is determined by summing the slip on the active slip systems. By building in the slip geometry known from the metallurgical literature, it is possible to predict the anisotropic deformation behavior and to model in a straightforward manner other phenomena which have been described by metallurgists in crystallographic terms. Elevated temperature tension-torsion tests were run and used to verify the model's predictive abilities. Ratchetting behavior under thermomechanical loading conditions is specifically addressed.
Author

A92-24721* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A VISCOPLASTIC THEORY FOR ANISOTROPIC MATERIALS
D. NOUAILHAS (ONERA, Chatillon, France) and A. D. FREED (NASA, Lewis Research Center, Cleveland, OH) ASME, Transactions, Journal of Engineering Materials and Technology (ISSN 0094-4289), vol. 114, Jan. 1992, p. 97-104. refs
Copyright

The purpose of this work is the development of a unified, cyclic, viscoplastic model for anisotropic materials. The first part of the paper presents the foundations of the model in the framework of thermodynamics with internal variables. The second part considers the particular case of cubic symmetry, and addresses the cyclic behavior of a nickel-base single-crystal superalloy, CMSX-2, at high temperature (950 C). Author

A92-24723
MEASUREMENTS OF THE PRESSURE AND VELOCITY DISTRIBUTION IN LOW-SPEED TURBOMACHINERY BY MEANS OF HIGH-FREQUENCY PRESSURE TRANSDUCERS
S. BRODERSEN and D. WULFF (Braunschweig, Technische Universitaet, Brunswick, Federal Republic of Germany) ASME, Transactions, Journal of Turbomachinery (ISSN 0889-504X), vol. 114, Jan. 1992, p. 100-107. refs
Copyright

The flow in a low-speed, single-state compressor with a very high blade loading has been measured using a two-probe arrangement. The measuring technique and data reduction procedure described have been especially adjusted for application in low-speed turbomachinery. Those machines show only small pressure fluctuations in the flow downstream of the rotor, for which specific requirements concerning the measuring technique have been taken into account. The probes used contain unsteady pressure transducers and simulate an unsteady multisensor pressure probe. This technique proves to be suitable for applications in low-speed turbomachinery. The measurements are based on phase-locked ensemble averages of multiple samples, where the data are acquired using a simple and convenient experimental setup. This allows the velocity and pressure distribution of the flow to be determined in rotor coordinates. The results show the flow field and the loss distribution of an aerodynamically highly loaded rotor at design flow rate. Author

A92-24730
3D LDA MEASUREMENT IN AN AXIAL FAN ROTOR
XIAOYU WANG, LIPING XU (Beijing University of Aeronautics and Astronautics, People's Republic of China), YUANZHONG CHEN, and YAN ZHU (Greatwall Precision Instrument Research Institute, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, Jan. 1992, p. 9-13. In Chinese. refs

A stacked three-dimensional Laser Doppler Anemometer (LDA) system has been developed on the basis of a one-dimensional and a two-dimensional LDA system. This system was successfully used in the measurement of the rotational flowfield inside a small axial fan rotor. The measurements reveal rich and complex flow structures near the blade tip region. In particular, fine helical vortex structures are obtained which prove the system a useful tool in turbomachinery flow measurement. Author

A92-24732
QUASI-STATIC ANALYSIS OF ROLLER BEARING
GUOCHANG LIN, CONGRU XU, and JISHU LIN (Shenyang Aeroengine Research Institute, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, Jan. 1992, p. 17-21. In Chinese. refs

The quasi-static analysis of radial cylindrical roller bearing is introduced. The influences of the out-of-round raceway, the relative inclination of the roller and race, and flexible deformation of the bearing housing on bearing performance are taken into consideration. The calculation of out-of-round raceway and the counter-rotating intershaft support bearing characteristics is studied. The precise determination of roller loading in an inclined inner race is presented, and the calculation of contact force on the inclined roller is carried out by means of the transverse 'slicing' technique. The maximum stress of the roller is calculated with the flexible two-dimensional contact variational method. The thermal effects of oil in Hertzian zone and the entry region and the oil starvation influence are also taken into account in the lubrication model. The main bearing in an aeroengine was calculated with a quasi-static analysis program. The agreement of calculated and experimental results is quite good. Author

A92-24737
PREDICATION OF FASTENING CAPACITY OF SCREWED JOINT STRUCTURE WITH CONE ASSEMBLY
BENHAN DONG and PENGFEI GAO (Shenyang Aeroengine Research Institute, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, Jan. 1992, p. 39-42. In Chinese.

A model test has been conducted to research the mechanical behavior of jointed parts in the assembling and loading process. The load-deformation relation of jointed parts reveals the difference between plane assembly and cone assembly. The relation of the former is linear and that of the latter nonlinear. In this research the loose condition of joint structure was defined experimentally that the strain of cone parts equals zero and the correlated load is named for loose load (or bearing capacity). Based on the test results, the cone assembly jointed structure increases loose load owing to the friction factor. Loose load of real jointed structure in an aeroengine has been predicted by means of the model test and the factors which have influence on bearing capacity are investigated. Author

A92-24747
AEROENGINE SENSOR FAILURE DETECTION BY BAYESIAN MULTIPLE HYPOTHESIS TESTING

DAZHONG JIANG and XIAOKUI WANG (Northwestern Polytechnical University, Xian, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, Jan. 1992, p. 81-84. In Chinese.

Analytical redundancy of the advanced sensor failure detection isolation and fault sensor output reconstruction obviously enhance the reliability of aircraft engine controls. The Bayesian multiple hypothesis testing is applied to detection isolation and accommodation of the hard failure. The hypothesis conditioned errors, the covariance matrices of the cost function and the optimal estimate are obtained from a bank of Kalman filters. An example using the microcomputer-based simulation indicates that the detective rate, the accuracy of output reconstruction, and the detectable minimum range and so on have an advantage over the Kalman filter residual in hard failure. Author

A92-24748
FAILURE DETECTION OF ENGINE SENSORS WITH A BANK OF KALMAN FILTERS
SHENGYUAN WANG (Beijing University of Aeronautics and Astronautics, People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, Jan. 1992, p. 85-88. In Chinese. refs

A detection method is presented for sensor failures in Full Authority Digital Engine Controls (FADEC) engine. In order to avoid that the output of a fault sensor affects other system states through state feedback, a bank of Kalman filters is used in which different combinations of sensor outputs as inputs of the filters are fed to each filter. According to the characteristics of innovation sequences of each filter, the failure can be detected and isolated. The sample frequencies are different in the feedback control path and the computation of innovation sequences. When a failure has occurred in one sensor but before the failure affects other system states, the failure can be detected and isolated effectively. Therefore, the effects of failure on the outputs of other sensors are avoided. A digital simulation has been made for a rotational-speed and temperature control system of a twin-spool turbine engine. The simulation results show that this failure detection and isolation method is effective. Author

A92-24749
STUDY ON THE RELIABILITY EVALUATION OF ENGINE FUEL ACCESSORIES
JIANHUA XUE, XIANFENG AI, and YIYU LIU (Xian Yuan Dong Machine Building Co., People's Republic of China) Journal of Aerospace Power (ISSN 1000-8055), vol. 7, Jan. 1992, p. 89-91. In Chinese. refs

Application of Bayes method to the reliability analysis of mechanical products is considered. The key to the application of Bayes statistics selection of prior probability has been solved by means of comparison and discrimination. Bayes statistics is of universal significance for the reliability analysis of complicated mechanical products. Satisfactory results can be achieved if the proper selection of prior probability is made. Author

A92-24758
THE JET EDGE-TONE FEEDBACK CYCLE - LINEAR THEORY FOR THE OPERATING STAGES
D. G. CRIGHTON (Cambridge, University, England) Journal of Fluid Mechanics (ISSN 0022-1120), vol. 234, Jan. 1992, p. 361-391. refs
(Contract N00014-81-G-0010; N00014-86-G-0066)
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A linear analytical model for predicting the frequency characteristics of the discrete oscillations of the jet-edge feedback cycle is presented. The jet is idealized as a top-hat jet with uniform flow between two vortex-sheet shear layers, which permits analytical investigation of the jet coupling to the nozzle and the jet interaction with the downstream splitter plate. The interaction of a flat plate inserted along the centerline of the jet with the splitter plate produces an irrotational feedback field which, near the nozzle exit, is a periodic transverse flow producing singularities at the nozzle lips. Vortex shedding is assumed to occur, alleviating the singularities and allowing a trailing-edge Kutta condition to be satisfied. The Kutta condition is claimed to be the phase-locking criterion. The shed vorticity develops into a sinuous spatial instability, and the cycle of events is repeated periodically. Physical processes are solved in an appropriate asymptotic sense by Wiener-Hopf methods. O.G.

A92-24778
FIBER OPTIC SENSORS FOR SMART SKINS APPLICATIONS
PETER RAITI (U.S. Navy, Naval Air Development Center, Warminster, PA) IN: Fiber optic smart structures and skins III; Proceedings of the Meeting, San Jose, CA, Sept. 19-21, 1990. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 6-19. refs
Copyright

Various sensor configurations useful in the prospective detection of perturbations in both polymeric composite and metallic materials are investigated. Attention is given to (1) a cross-point coordinate axis impact-and-location sensor, and (2) a strain gage-functioning tapered sensor for stress and crack detection. Crack initiation should be detectable if it occurs perpendicular to the sensor's line-of action, in the region between contact pads. O.C.

A92-24908
INDUSTRY WARMS TO CFD
AUGUST VERHOFF (McDonnell Aircraft Co., Saint Louis, MO), ROBERT E. MELNIK (Grumman Corporate Research Center, Bethpage, NY), and JAMES E. CARTER (United Technologies Research Center, East Hartford, CT) Aerospace America (ISSN 0740-722X), vol. 30, Feb. 1992, p. 32-35, 47.
Copyright

Many U.S. industrial organizations are currently implementing adaptive gridding techniques and unstructured grid methods to streamline CFD processing and enhance CFD flow prediction accuracy. Adaptive-grid strategies couple grid generation with the flow solution algorithm; grid points are moved, added, or deleted in the field dynamically, as dictated by local flow gradients. Unstructured grids are similar to finite-element grids, and allow detailed resolution of geometric and flowfield features. Tools for displaying, manipulating, and analyzing the vast quantities of data contained in a CFD solution are required for full exploitation of CFD capabilities. Sophisticated interactive systems are being developed for workstations. O.C.

A92-24909
EUROPE PRESENTS A UNITED CFD FRONT
WOLFGANG SCHMIDT (MBB GmbH, Munich, Federal Republic of Germany) Aerospace America (ISSN 0740-722X), vol. 30, Feb. 1992, p. 36-39.
Copyright

The European Committee on Flow, Turbulence, and Combustion has created research centers and channels for intensive cooperation in CFD research throughout Western Europe. CFD applications are useful in aircraft design only in conjunction with validated methods and rapid handling of mesh-generation for complex configurations; an interactive mesh-generation system that uses CAD-CAM files for geometry has been developed to an attractive standard, and both structured and unstructured mesh strategies are being pursued. O.C.

A92-24911
WEAVING AN AIRCRAFT
RICHARD PIELLISCH Aerospace America (ISSN 0740-722X), vol. 30, Feb. 1992, p. 54, 55.
Copyright

Such novel composites-manufacturing technologies currently under development by NASA-Langley's Advanced Composite Technology program as 3D weaving, advanced braiding, through-the-fabric stitching, and textile preforms, are essential to the commercialization of large primary structures for aircraft. Advanced fiber-placement methods constitute a related technology of increasing utility. Efforts are being made to harness the most

highly automated techniques of the textiles industry to create near-net-shape preforms, to obtain labor costs that are a fraction of the cost of traditional laminate composite layups. O.C.

A92-24980

CONTROL OF LAMINAR BOUNDARY LAYER SEPARATION

A. V. DOVGAL' and V. V. KOZLOV (Academy of Sciences of the USSR, Institute of Theoretical and Applied Mechanics, Novosibirsk) *Russian Journal of Theoretical and Applied* Mechanics (ISSN 1051-8045), vol. 1, June 1991, p. 103-109. refs

Copyright

Possibilities of controlling laminar boundary layer separation are discussed with particular attention given to the 'sensitivity' of separation regions to external periodic forcing. The formation of transitional separated flows is related to an associated laminar-turbulent transition, which in turn is governed by outflow disturbances. It is suggested that it is possible to operate transitional separated flows by means of flow adjustment and imposition of external disturbances even of small amplitudes. The NASA 63(420)-517 airfoil has been tested at Reynolds number 200,000 in the low turbulent wind tunnel to study the effect of suction on a transitional separation bubble occurring in an adverse pressure gradient region of the airfoil. Suction is found to result in filling of the velocity profile and suppressing the disturbances of laminar flow. O.G.

A92-25014

THE MEASUREMENT OF FLUTTER DERIVATIVES USING MECHANICAL ADMITTANCE

MINGSHUI LI, XIN CHEN, and DEXIN HE (China Aerodynamics Research and Development Center, Mianyang, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 9, Dec. 1991, p. 482-487. In Chinese. refs

The effects of vortex-induced vibrations on the experimental measurement of flutter derivatives are studied using Scanlan's method. To reduce these effects, a preliminary method, mechanical admittance, is proposed. Experimental results show that flutter derivatives using this method are very close to the ideal curve, except a slight distortion near the reduced wind speed of lock-in. In addition, a new method that can be used to distinguish between flutter and vortex-induced vibration is proposed. Author

A92-25109

THE LDV MEASUREMENT OF THREE-COMPONENT VELOCITY OF COMPLEX VORTEX FLOW IN THE WIND TUNNEL

MINZHONG TANG (Harbin Aerodynamics Institute, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 9, Sept. 1991, p. 356-360. In Chinese. refs

This paper reports that a two-component TSI 9100-7 LDV system was developed into the LDV to measure three component velocity and that with the developed LDV the complex vortex flow field of a prolate spheroid and a double-delta wing at high angle of attack in a wind tunnel was measured. The test wind velocity was 20 m/s. The obtained velocity vector distribution in the measured plane coincide with the flow visualization results under the same test conditions. In addition the vortex flow field was analyzed. Author

A92-25138

A NUMERICAL CALCULATION OF THREE DIMENSIONAL INCOMPRESSIBLE LAMINAR, TRANSITION AND TURBULENT BOUNDARY LAYERS

JIAXIANG YAN and BIN YU (Northwestern Polytechnical University, Xian, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 9, June 1991, p. 265-269. In Chinese. refs

A method is presented for calculating the 3D boundary layers in incompressible viscous flow, including a differential method for laminar boundary layers, an integral method for turbulent boundary layers, and a numerical solution method for the Orr-Sommerfeld equation in which transition occurs only if the amplification of the disturbance reaches a certain level. These methods are used to calculate a swept-wing ONERA M6. C.D.

A92-25366

THE EFFECTS OF SUCTION ON THE NONLINEAR STABILITY OF THE THREE-DIMENSIONAL BOUNDARY LAYER ABOVE A ROTATING DISC

ANDREW P. BASSOM (Exeter, University, England) and SHARON O. SEDDOUGUI (Birmingham, University, England) Royal Society (London), Proceedings, Series A - Mathematical and Physical Sciences (ISSN 0962-8444), vol. 436, no. 1897, Feb. 8, 1992, p. 405-415. Research supported by ICASE. refs

Copyright

There exists two types of stationary instability of the flow over a rotating disk corresponding to the upper-branch, inviscid mode and the lower-branch mode, which has a triple deck structure, of the neutral stability curve. This paper investigates the effects of suction on the nonlinear disturbance described by MacKerrell (1987). The additional analysis required to incorporate suction is relatively straightforward and makes it possible to derive an amplitude equation which describes the evolution of the mode. For each value of the suction a treshold value of the disturbance amplitude is obtained; modes of size greater than this treshold grow without limit as they develop away from the point of neutral stability. Author

A92-25505

A QUICK AUTOMATIC METHOD FOR COMPUTING PERFORMANCE OF NONDUCTED PROPELLER WITH CONSTANT-REVOLUTIONAL-SPEED

SHIGENORI ANDO and MICHIYO KATO Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 39, no. 455, 1991, p. 675-679. In Japanese. refs

A quick automatic method is presented for computing performance of a nonducted propeller with constant revolutional speed. This study is motivated by its usefulness for developing WIG vehicles, namely in order to predict propeller data to be used. Results of computation examples show that constant-speed propellers are considerably robust, viz. insensitive to change of some parameters such as diameter, solidity, and rotational speed. It is noteworthy that these well-known properties are confirmed easily and quickly by the present method. Author

A92-25535

SIMULATION OF ARBITRARY CRACK PROPAGATION IN THREE-DIMENSIONS

LUIZ F. MARTHA, PAUL A. WAWRZYNEK, and ANTHONY R. INGRAFFEA (Cornell University, Ithaca, NY) IN: Numerical methods in fracture mechanics; Proceedings of the 5th International *Conference, Freiburg im Breisgau, Federal Republic of Germany,* Apr. 23-27, 1990. Swansea, Wales, Pineridge Press, 1990, p. 115-127. refs

Copyright

An interactive computer-aided design tool has been developed which is capable of simulating the performance of structures containing generic flaws of different sizes at various locations. The system provides state-of-the-art visualization techniques for evaluating structural performance, including animated flaw growth. The system is designed for implementation on a mid-range engineering workstation with hardware-supported 3D graphics capabilities. To illustrate the efficiency of the system, crack propagation in an aircraft component is examined as an example. V.L.

A92-25693#

CHARACTERIZATION OF A TWO-PHASE FLOW FIELD DOWNSTREAM OF A 3X-SCALE GAS TURBINE CO-AXIAL, COUNTER-SWIRLING, COMBUSTOR DOME SWIRL CUP

H. Y. WANG, V. G. MCDONELL, W. A. SOWA, and G. S. SAMUELSEN (California, University, Irvine) AIAA, Aerospace *Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 8*

p. Research supported by GE Aircaft Engines. refs
(AIAA PAPER 92-0229) Copyright

Both the droplets and continuous phase (gas in the presence of the droplets) downstream of a 3x model combustor dome swirl cup are characterized in the absence of reaction. Continuous-phase and droplet velocities as well as droplet size were measured using phase Doppler interferometry. The measurements reveal that: (1) at the exit plane of the swirl cup assembly, more uniform and finer droplets are produced relative to the atomizer alone; (2) both the continuous phase and the droplets recirculate; (3) the location at which droplets join the recirculation is correlated with droplet size; and (4) significant slip velocities between the continuous phase and the droplets reflect a strong momentum exchange between the phases. Author

A92-25716#
ULTIMATE STRENGTH PREDICTION OF ASTM D - 3039 TENSILE SPECIMENS FROM ACOUSTIC EMISSION AMPLITUDE DATA
JAMES L. WALKER, II (Embry-Riddle Aeronautical University, Daytona Beach, FL) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 14 p. refs
(AIAA PAPER 92-0258) Copyright

This paper demonstrates how the qualitative analysis of AE data can be refined to provide a quantitative tool for predicting the ultimate strength of composite tensile-test specimens. From an original sample set of only six specimens, a multivariate statistical analysis was used to generate an ultimate-strength prediction equation. The variables of the multivariate statistical analysis were obtained through the mathematical modeling of the specimen's AE amplitude distributions produced during proof testing. The amplitude data was statistically modeled with a Weibull distribution. Ultimate strengths were then accurately predicted at proof stresses less than 25 percent of the expected failure stress for five randomly drawn tensile coupons. The results of this research demonstrate the feasibility of accurately predicting ultimate strengths in composite structure using AE amplitude-distribution data. Author

A92-25720#
AERODYNAMIC APPLICATIONS OF PRESSURE-SENSITIVE PAINT
M. J. MORRIS, J. F. DONOVAN, J. T. KEGELMAN, S. D. SCHWAB, R. L. LEVY (McDonnell Douglas Research Laboratories, Saint Louis, MO), and R. C. CRITES (McDonnell Aircraft Co., Saint Louis, MO) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 11 p. Research supported by McDonnell Douglas Corp. refs
(AIAA PAPER 92-0264) Copyright

A pressure measurement technique based on a photoluminescent coating is being developed and used for aerodynamic applications. Visible light excites probe molecules in the paint and their luminescence is related to the static pressure. Details of the illumination, luminescence detection, and data reduction for this technique are presented. These include key issues such as temperature effects and calibration. Results from this technique in a variety of flowfields are given. Comparisons with pressures measured using standard wall taps show good agreement. Author

A92-25786*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
THERMOCHEMICAL NONEQUILIBRIUM AND RADIATIVE INTERACTIONS IN SUPERSONIC HYDROGEN-AIR COMBUSTION
R. CHANDRASEKHAR and S. N. TIWARI (Old Dominion University, Norfolk, VA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 13 p. refs
(Contract NAG1-423)
(AIAA PAPER 92-0340) Copyright

The two-dimensional, elliptic Navier-Stokes equations are used to investigate supersonic flows with nonequilibrium chemistry and thermodynamics, coupled with radiation, for hydrogen-air systems. The chemistry source term in the species equation is treated implicitly to alleviate the stiffness associated with fast reactions. The explicit, unsplit MacCormack finite-difference scheme is used to advance the governing equations in time, until convergence is achieved. The specific problem considered is the premixed, expanding flow in a supersonic nozzle. The reacting flow consists of seven species, one of which is the inert N2 molecule. The thermal state of the gas is modeled with one translational-rotational temperature and five vibrational temperatures. The harmonic oscillator model is used in the formulation for vibrational relaxation. The tangent slab approximation is used in the radiative flux formulation. A pseudo-gray model is used to represent the absorption-emission characteristics of the participating species. Results obtained for specific conditions indicate the presence of nonequilibrium in the expansion region. This reduces the radiative interactions and can have a significant influence on the flowfield. Author

A92-25846
BUILT-IN TESTABLE ERROR DETECTION AND CORRECTION
MEHDI KATOOZI and ARNOLD W. NORDSIECK (Boeing High Technology Center, Seattle, WA) IEEE Journal of Solid-State Circuits (ISSN 0018-9200), vol. 27, Jan. 1992, p. 59-66. refs
Copyright

A method for design of built-in testable (BIT) error detection and correction (EDAC) circuits is presented that uses up to 65 percent less test hardware than customary BIT implementations. A 1-micron 16-b EDAC designed and fabricated with this technique exhibits more than 99 percent fault coverage in 10 microsec at 25 MHz. Built-in test impacts the speed performance by only one gate delay regardless of the size of the EDAC. Various faults are injected into the chip to verify the effectiveness of built-in test. I.E.

A92-26219* National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.
UNSTEADY INCOMPRESSIBLE FLOW COMPUTATIONS WITH QUADRILATERAL ELEMENTS
T. E. TEZDUYAR, R. SHIH, and S. MITTAL (Minnesota, University, Minneapolis) IN: Computing methods in applied sciences and engineering; Proceedings of the 9th International Conference, Paris, France, Jan. 29-Feb. 2, 1990. Philadelphia, PA, Society for Industrial and Applied Mathematics, 1990, p. 228-248. refs
(Contract NAS9-17892; NSF MSM-87-96352)
Copyright

A comparative investigation, based on a series of numerical tests, of various velocity-pressure elements used for incompressible flow computations is presented. These elements are implemented in conjunction with one-step and multi-step temporal integration of unsteady Navier-Stokes equations. The test cases chosen are the standing vortex problem, the lid-driven cavity flow, and flow past a circular cylinder. Author

A92-26227*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
LOW-TO-HIGH ALTITUDE PREDICTIONS OF THREE-DIMENSIONAL ABLATIVE REENTRY FLOWFIELDS
BILAL A. BHUTTA and CLARK H. LEWIS (VRA, Inc., Blacksburg, VA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 23 p. refs
(Contract NAS3-25450)
(AIAA PAPER 92-0366) Copyright

A new coupled-chemistry PNS scheme has been developed to study 3D hypersonic reentry flows over sphere cones at small angles of attack. A new quasi-steady ablation model for Teflon was used to predict ablative reentry flow fields under laminar, transitional, and turbulent conditions. This solution scheme uses a new two-step solution scheme for solving the species conservation equations under low-altitude conditions. As an example, the scheme is used to study hypersonic flow over a 6-deg sphere-cone configuration at 50 and 125 kft conditions under zero and nonzero angle of attack conditions. C.D.

A92-26235#
AN OPTICAL MICROPHONE FOR THE DETECTION OF HIDDEN HELICOPTERS
CECIL F. HESS (MetroLaser, Irvine, CA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 9 p. refs
(Contract DAAH01-90-C-0813)
(AIAA PAPER 92-0377) Copyright

A laser-Doppler microphone is described that is designed to measure acoustic disturbances near acoustic radiators such as helicopters. A numerical analysis is conducted of the maximum displacement of 110-micron at a helicopter source. Experimental studies are described which suggest that the acoustic pressure, which is higher near the source, can be used to locate a helicopter. A small speaker is used as the acoustic radiator and a reference-beam laser-Doppler system is employed to measure the frequency associated with particle vibration and convection. The longitudinal displacement correlates with the distance from the helicopter to the laser-Doppler microphone, and the microphone can detect disturbances smaller than 1 micron. The experimental results showed that measurements of acoustic frequencies of 100-400 Hz are accurate to about 5 percent, and the concept can be used to detect and locate hidden helicopters. C.C.S.

A92-26249#
LASER MEASUREMENTS OF UNSTEADY FLOW FIELD IN A RADIAL TURBINE GUIDE VANES
M. PASIN and W. TABAKOFF (Cincinnati, University, OH) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 13 p. refs
(Contract DAAL03-90-G-0129)
(AIAA PAPER 92-0394) Copyright

Detailed measurements of a unsteady flow field within the inlet guide vanes (IGV) of a radial inflow turbine were performed using a three component Laser Doppler Velocimeter (LDV) system. The mean velocity, the flow angle and the turbulence results are presented at the midspan plane for different rotor positions. These results are compared with the measurements obtained in the same passage in the absence of the rotor. Author

A92-26302#
INTERFACIAL INSTABILITY BETWEEN A LIQUID FILM AND THE SURROUNDING COMPRESSIBLE GAS
H. Q. YANG (CFD Research Corp., Huntsville, AL) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 8 p. refs
(AIAA PAPER 92-0461) Copyright

Recent interest in hypersonic aircraft has promoted research in supersonic combustion. One of the fundamental issues to be addressed is the spray and atomization in the supersonic flow. In the present work, the influence of Mach number on the interfacial instability between a liquid film and the surrounding compressible gas is investigated. It is found that for an asymmetric mode, the gas compressibility has a damping effect on the liquid film breakup, and the influence is generally very small. For a symmetric mode, the growth of a distribution is independent of Mach number. Author

A92-26413
LASER VELOCIMETRY SEED PARTICLES WITHIN COMPRESSIBLE, VORTICAL FLOWS
MARK S. MAURICE (USAF, Wright Laboratory, Wright-Patterson AFB, OH) AIAA Journal (ISSN 0001-1452), vol. 30, Feb. 1992, p. 376-383. Previously cited in issue 06, p. 797, Accession no. A91-19222. refs

A92-26433
SHAPE-SENSITIVITY ANALYSIS AND DESIGN OPTIMIZATION OF LINEAR, THERMOELASTIC SOLIDS
GENE J. W. HOU, JEEN S. SHEEN, and CHING H. CHUANG (Old Dominion University, Norfolk, VA) AIAA Journal (ISSN 0001-1452), vol. 30, Feb. 1992, p. 528-537. Previously cited in issue 11, p. 1692, Accession no. A90-29248. refs
Copyright

A92-26436* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
PRECONDITIONED UPWIND METHODS TO SOLVE INCOMPRESSIBLE NAVIER-STOKES EQUATIONS
C.-H. HSU (Vigyan, Inc., Hampton, VA), Y.-M. CHEN, and C. H. LIU (NASA, Langley Research Center, Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 30, Feb. 1992, p. 550-552. Previously cited in issue 16, p. 2481, Accession no. A90-38646. refs
(Contract NAS1-18585)
Copyright

A92-26437* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
APPLICATION OF A NEW K-TAU MODEL TO NEAR WALL TURBULENT FLOWS
S. THANGAM, R. ABID, and C. G. SPEZIALE (NASA, Langley Research Center, Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 30, Feb. 1992, p. 552-554. Previously cited in issue 06, p. 800, Accession no. A91-19383. refs
(Contract NAS1-18605)
Copyright

A92-26776
ETS-V/EMSS MOBILE SATELLITE COMMUNICATION EXPERIMENTS
KIMIO KONDO and SHINGO OHMORI Communications Research Laboratory, Review (ISSN 0914-9279), vol. 36, no. 10, March 1990, p. 3-9. In Japanese. refs

With the launch of ETS-V in August 1987, the Experimental Mobile Satellite System (EMSS) was developed. Several types of mobile satellite communication experiments are performed including: (1) a training ship with a 40-cm JSBF antenna for ship experiments; (2) aircraft experiments a Boeing 747 cargo aircraft with a 16-element phased-array antenna; and (3) the ACSSB, QPSK, or spread-spectrum modems employed as land mobile terminals. Experiments with a train and a portable message communicator were also performed. International cooperative experiments in land mobile-satellite communications with AUSSAT are also mentioned. The results and future plans of ETS-V mobile communication experiments are reviewed. Author

A92-26779
EXPERIMENTS ON AERONAUTICAL SATELLITE COMMUNICATIONS USING ETS-V
SHINGO OHMORI, YOSHIHIRO HASE, HIROMITSU WAKANA, SHINICHI TAIRA, and TOSHIYUKI IDE Communications Research Laboratory, Review (ISSN 0914-9279), vol. 36, no. 10, March 1990, p. 27-37. In Japanese. refs

Experiments are performed on aeronautical satellite communcations using a commercial aircraft over transoceanic flight routes. The satellite is the ETS-V which was launched on the geostationary orbit of 150 deg E. Characteristics of an airborne antenna are found to be the most important function, which is closely related to such factors as the G/T, effects of fading, and beam-scanning errors. The results are described of fading, bit-error rates, channel interference, and other important results. Author

A92-26795
RESONANCE OF CIRCULAR SHOCK WAVES
MYEONG-KWAN PARK, SHUZO OSHIMA, and RYUICHIRO YAMANE (Tokyo Institute of Technology, Japan) JSME International Journal, Series II (ISSN 0914-8817), vol. 35, Feb. 1992, p. 16-22. refs
Copyright

Resonance effects in a supersonic centrifugal compressor or disk MHD power generator have been studied, focusing on oscillation modes of a circular shock wave. The pressure fluctuation components of the higher harmonic modes of the excitation frequency were observed in the downstream stagnation chamber

by rotating the valve. Resonance effects were found with the perturbation components of the downstream higher harmonic mode at the natural frequency. Theoretical analysis confirms that resonance occurs when the excitation frequency is equal to the natural frequency of the shock wave. The small perturbation of the higher harmonic modes in the downstream stagnation chamber affected the oscillation modes of the circular shock wave. O.G.

A92-26799

DURABILITY ANALYSIS USING FRACTURE MECHANICS FOR AVIONICS INTEGRITY

ALAN H. BURKHARD and CHRIS E. LEAK (USAF, Wright Laboratory, Wright-Patterson AFB, OH) IES, Journal (ISSN 1052-2883), vol. 35, Jan.-Feb. 1992, p. 26-32. refs
(Contract F33615-87-C-3403)
Copyright

An Electronics Reliability Fracture Mechanics program is discussed which is aimed at developing a life prediction approach based on fracture mechanics concepts for electronic assemblies subjected to the environmental stresses of vibration and thermal cycling. Two shop-replaceable units from the F-15 aircrafts's APG-63 radar were studied. Emphasis is placed on mobile ionic and surface contamination, contamination life models, wire bond fracture, and the use of plated through holes. Fracture mechanics techniques are found to be suitable for assessing the durability of electronics. O.G.

A92-26935*# National Aeronautics and Space Administration, Washington, DC.

EVALUATION OF OH LASER-INDUCED FLUORESCENCE TECHNIQUES FOR SUPERSONIC COMBUSTION DIAGNOSTICS

T. M. QUAGLIAROLI, G. LAUFER, R. H. KRAUSS, and J. C. MCDANIEL, JR. (Virginia, University, Charlottesville) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 11 p. refs
(Contract NGT-50714)
(AIAA PAPER 92-0508) Copyright

The limitations on application of dye laser and narrowband tunable KrF excimer laser systems to planar OH fluorescence measurements in supersonic combustion test facilities are examined. Included in the analysis are effects of collisional quenching, beam absorption, fluorescence trapping, and signal strengths on achievable measurement accuracy using several excitation and detection options for either of the two laser systems. Dye-based laser systems are found to be the method of choice for imaging OH concentrations less than 10 exp 15 per cu cm, while the KrF based systems provide significant reduction in measurement ambiguity for concentrations in excess of 10 exp 15 per cu cm. Author

A92-26939#

UV LASER SPECTROSCOPIC MEASUREMENTS IN JET ENGINE COMBUSTION EXIT FLOWS

JOHN A. SHIRLEY (United Technologies Research Center, East Hartford, CT) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 10 p. Research supported by Pratt and Whitney Group. refs
(AIAA PAPER 92-0513) Copyright

Laser diagnostic measurements, which are excited with a narrowband krypton fluoride laser, have been made at the exit of a jet engine combustor. Spectra of Raman scattering and laser induced fluorescence were measured with a 0.5 meter spectrograph equipped with a diode array detector. For these demonstration tests, the combustor was operated at two flow rates including conditions corresponding to the 90 percent power level, with jet fuel and methane. Nitrogen Raman spectra are free of band interference. However, the signal levels are lower than expected. Sources of signal losses are discussed. Author

A92-26952#

NUMERICAL SIMULATION OF TOTAL TEMPERATURE SEPARATION IN JETS

LINDA S. HEDGES and SCOTT EBERHARDT (Washington, University, Seattle) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 14 p. Research supported by NSF. refs
(AIAA PAPER 92-0535) Copyright

A compressible, circular jet has been numerically simulated to further understand the physical mechanisms responsible for heat transfer within a jet. The purpose of this paper is to computationally model the jet to verify theory and further the understanding of the heat transfer process. The direct numerical simulations solve the nonsteady Euler equations with the TVD finite difference technique. The computational simulations provide access to instantaneous and time-averaged flow parameters, pathlines, and flow visualization. The simulations compare well with experimental results and support a previously formulated vortex dynamical model for total temperature separation in jets. The simulations verify that total temperature separation is due to the low pressure centers of the large scale vortical structures and demonstrate how particle pathlines are influenced by the unsteady nature of the flow. Author

A92-27009*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

EXPERIMENTS ON SHEAR LAYER MIXING AT HYPERVELOCITY CONDITIONS

JOHN ERDOS, JOSE TAMANGO, ROBERT BAKOS, and RICHARD TRUCCO (General Applied Science Laboratories, Inc., Ronkonkoma, NY) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 14 p. refs
(Contract NAS1-18450)
(AIAA PAPER 92-0628) Copyright

Utilization of an expansion tube to acquire turbulent, compressible free shear layer data with gases of direct relevance to hypersonic combustion systems (nitrogen, hydrogen, and oxygen) is demonstrated. Visualizations of the free shear layer by laser holographic interferometry and schlieren imaging show a distinctly asymmetric growth rate that is highly preferential toward the lower speed (secondary stream) side. For the nitrogen/nitrogen case, for which the convective velocity was lowest and convective Mach number highest, the growth rate on the primary side was virtually zero until the mixing layer reached the opposite (secondary) wall. R.E.P.

A92-27029#

TRANSMISSION OF THIN LIGHT BEAMS THROUGH TURBULENT MIXING LAYERS

JOHN B. WISSLER and ANATOL ROSHKO (California Institute of Technology, Pasadena) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 28 p. refs
(Contract AF-AFOSR-89-0552)
(AIAA PAPER 92-0658) Copyright

This research investigates the effects of spanwise and streamwise coherent structures in a turbulent mixing layer on the deflection of a thin light beam which is transmitting transversely through the mixing layer from the high-speed side to the low speed side. Both equal and unequal density mixing layers of varying pressures and velocities are studied, using a lateral effect detector to dynamically track the motion of a He-Ne laser beam. Beam deflections in the streamwise direction are found to be associated mainly with the spanwise coherent structures; at low Reynolds numbers the beam deflection is directly related to the part of a spanwise structure through which the beam passes. Maximum deflections are associated with the trailing edge of the spanwise coherent structures. Spanwise deflections are caused mainly by the streamwise coherent structures and as such exhibit large variations across the span of the flow. With the development of the streamwise structures, spanwise deflections are found to exceed streamwise deflections. Mixing transition, as scaled using the momentum thickness of the high-speed side, is found to cause a peak in the rms fluctuations of both the streamwise and spanwise deflections. Author

A92-27032#

THREE-DIMENSIONAL ADAPTIVE GRID GENERATION WITH APPLICATIONS IN NONLINEAR FLUID DYNAMICS

LEE KANIA (Sverdrup Technology, Inc., Structures and Dynamics Dept., Huntsville, AL) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 10 p. refs
(AIAA PAPER 92-0661)

An algebraic adaptive grid scheme applicable to 3D problems in fluid dynamics is presented. The scheme utilizes an iterative procedure to relocate grid points in response to the gradient of any flow-field-dependent variable. Boundary points, while constrained to remain on the respective boundary surface, are premitted to move in order to maintain local levels of orthogonality without the use of conventional surface splines. The methodology has been applied to a test problem in which the local weighting is determined using an algebraic function, a blunted cone at 15 deg angle of attack immersed in a Mach 2.0 flow, and a generic fuselage forebody with canopy immersed in a Mach 0.925 flow. The method is conceptually simple and appears quite robust, although some method might be required to control excessive grid skewness. Solution resolution is demonstrated to be much improved.
Author

A92-27482

A VARIATIONAL METHOD FOR SOLVING THE PROBLEM OF MOTION OF A PROFILE OF COMPLEX GEOMETRY IN A FLUID [VARIATSIINII METOD ROZV'IAZANNIA ZADACHI PRO RUKH PROFILIA SKLADNOI GEOMETRICHNOI FORMI V RIDINI]

N. I. PARFENENKO (AN Ukrainy, Institut Gidromekhaniki, Kiev, Ukraine) Akademiia Nauk Ukrains'koi RSR, Dopovidi, Matematika, Prirodoznavstvo, Tekhnichni Nauki (ISSN 0868-8052), March 1991, p. 53-56. In Ukrainian. refs
Copyright

An approximate method is developed for determining the dynamic characteristics (attached masses and moments of inertia) of a plane body of arbitrary geometrical shape moving in an infinite ideal incompressible fluid. The approach is based on the application of inversion and a variational method to the corresponding boundary value problems formulated in transformed finite-dimensional regions. Results of numerical calculations are presented for the motion of bodies of specific geometry. V.L.

A92-27770

PREMIXED, TURBULENT COMBUSTION OF AXISYMMETRIC SUDDEN EXPANSION FLOWS

S. A. AHMED and A. S. NEJAD (USAF, Aero Propulsion and Power Directorate, Wright-Patterson AFB, OH) International Journal of Heat and Fluid Flow (ISSN 0142-727X), vol. 13, March 1992, p. 15-21. Research sponsored by USAF. refs
Copyright

Velocity and low-frequency combustor-pressure oscillations are measured in a ramjet-dump combustor model. The mean and rms values of the turbulent velocity field were obtained using a two-component laser-Doppler-velocimeter system operating in the backscatter mode. Reacting flow data were obtained for premixed propane and air, while isothermal results were collected after replacing the propane with nitrogen. The velocity data indicated substantial differences between the two cases. Combustor-pressure oscillation data were also obtained. The intensity and frequency of the oscillations were found to be dependent on inlet velocity, combustor length, and equivalence ratio. Results showed that pressure oscillations were controlled by both vortex kinematics in the combustor and acoustic response of the inlet section.
Author

A92-27773

THREE-DIMENSIONAL BUOYANCY-INDUCED FLOW AND HEAT TRANSFER AROUND THE WHEEL OUTBOARD OF AN AIRCRAFT

C. DESAI and K. VAFAI (Ohio State University, Columbus) International Journal of Heat and Fluid Flow (ISSN 0142-727X), vol. 13, March 1992, p. 50-64. Research supported by BF Goodrich Co. and Ohio Supercomputer Center. refs
Copyright

Three-dimensional buoyancy-driven flow and heat transfer in an annular cavity with an end open to the ambient surroundings were numerically simulated. This geometry finds direct application in the wheel outboard portion of an aircraft brake housing and plays an important role in the thermal performance of the brake housing assembly. The virtually unknown boundary conditions at the open end were implemented by making use of an extended computational domain at the open end. The numerical scheme used in the present study is based on the Galerkin method of finite element formulation. A number of interesting features of the flow and heat transfer fields resulting from the sudden heating of the inner cylinder were studied in detail. Results including the local and average Nusselt numbers were obtained for a wide range of Rayleigh numbers, and it was found that the physics of the flow changes considerably at high Rayleigh numbers. The effort of the length of the inner cylinder on the flow field and the heat transfer coefficients were studied thoroughly. The validity of the numerical code used in ascertained by comparing results for some pertinent annular geometries with previously published results.
Author

A92-27783

FIBRE OPTIC LASER ANEMOMETRY FOR TURBOMACHINERY APPLICATIONS

N. A. AHMED, S. HAMID, R. L. ELDER, C. P. FORSTER, R. P. TATAM (Cranfield Institute of Technology, England), and J. D. C. JONES (Heriot-Watt University, Edinburgh, Scotland) Optics and Lasers in Engineering (ISSN 0143-8166), vol. 16, no. 2-3, 1992, p. 193-205. refs
Copyright

Two fiber optic based laser anemometers for flow measurement inside turbomachinery are presented. A two-spot anemometer is described that has been utilized to measure flows in an axial compressor at velocities up to 40/ms. The second instrument is a novel 3D laser Doppler velocimeter that uses a technique of oblique backscatter to allow sequential measurement of the three orthogonal velocity components. This instrument is shown to produce 3D measurements in a centrifugal compressor operating at up to 30,000 rpm with velocities up to 100/ms. Author

A92-27838

RELIABILITY ASPECTS IN COMPUTER INTEGRATED MANUFACTURING SYSTEMS

KAIYUAN CAI, CHUANYUAN WEN, and ZONGJI CHEN (Beijing University of Aeronautics and Astronautics, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, Oct. 1991, p. B523-B527. In Chinese. refs

An introduction to a computer integrated manufacturing system (CIMS) applied to a flight control system (FCS) is presented. Twelve measures to assure the reliability of this FCS-CIMS are then proposed. As a CIMS is usually degradable, the system cannot be simply determined as fully functioning or fully failed, and thus a fuzzy approach should be employed to model the system reliability behavior. R.E.P.

A92-27856

DYNAMIC ANALYSIS OF ANNULAR CASCADE SHROUDED BLADES

JIN ZHANG (Beijing University of Aeronautics and Astronautics, People's Republic of China), WENLIANG WANG (Fudan University, Shanghai, People's Republic of China), XIANGJUN CHEN, and JUN ZANG (Wuxi Aeroengine Institute, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, Sept. 1991, p. A474-A481. In Chinese. refs

An advanced method is presented for analyzing the dynamic behavior of the annular cascade shrouded blades used in compressor and turbine rotors of engines. The method is considered a combination of chain-loading and the group algorithm. It is applicable to the investigation of the complete effect caused by blade shrouds. The general analytical procedures and equations

are shown. The extension of the dynamic analysis for structures which have both periodically cyclosymmetric and annular cascade characteristics can be realized accurately. Author

A92-27865

APPLICATION RESEARCHES ON EXPERT SYSTEM USED FOR STRUCTURAL LAYOUT OPTIMIZATION OF WINGS

LINSHU HE and XIAOPING ZENG (Beijing University of Aeronautics and Astronautics, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, Sept. 1991, p. A533-A536. In Chinese. refs

An expert system has been used to study the structural layout optimization of aircraft wings. A man-machine interactive technique was used and a program named SLOW (Structural Layout of Wings) was created for engineering application. Users can select different wing layouts using SLOW and can choose the optimum layout from a number of different designs. C.D.

A92-27903

A SUPERELEMENT SIMPLIFIED ANALYSIS FOR THE VIBRATION SYSTEMS OF THE COMPLEX STRUCTURES

GUOPING CHEN and DEMAO ZHU (Research Institute of Vibration Engineering, People's Republic of China) Nanjing Aeronautical Institute, Journal (ISSN 1000-1956), vol. 24, Feb. 1992, p. 19-26. In Chinese. refs

A superelement analysis method based on the common finite element modeling is developed to reduce the DOF for the vibration systems of large complex structures. A simplified dynamic reduction is used in the internal domains of the superelements, and a local displacement field reassumption is introduced on the boundary areas. This method greatly reduces the order of DOF, facilitates solution, and is simple to program and convenient to calculate. A reduction criterion of internal DOF is suggested through the perturbation analysis. Some numerical examples verify that the method is very effective and has high calculation precision. Author

A92-27908

ADVANCES OF CRYOGENICS IN AERONAUTICS AND ASTRONAUTICS

LIXIN YOU (Nanjing Aeronautical Institute, People's Republic of China) Nanjing Aeronautical Institute, Journal (ISSN 1000-1956), vol. 24, Feb. 1992, p. 69-80. In Chinese. refs

The application principles of cryogenic techniques in aerospace are discussed in detail. Recent advances are addressed, including those made in China. These include: (1) characteristics and applications of rockets propelled by cryogenic liquid hydrogen (LOH)/LOX fuels and those propelled by a new generation of cryogenic liquid propellants; (2) characteristics and status of LOH/LOX-fueled and LNG-fueled aircraft; (3) principles and working envelopes of cryogenic wind tunnels performing aerodynamic experiments at full-scale Re; (4) the main application fields of cryogenics in space technology and their requirements regarding refrigeration temperature and load; (5) the application of cryogenics to fields such as cooling reentry flight vehicles, space simulation facilities, environmental control systems for flight vehicles, and life support systems. C.D.

A92-28031* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

MODELS OF SPACE-AVERAGED ENERGETICS OF PLATES

O. M. BOUTHIER and R. J. BERNHARD (Purdue University, West Lafayette, IN) AIAA Journal (ISSN 0001-1452), vol. 30, March 1992, p. 616-623. Previously cited in issue 02, p. 227, Accession no. A91-12437. refs

(Contract NAG1-58)

Copyright

A92-28033

ALGEBRAIC TURBULENCE MODELING FOR ADAPTIVE UNSTRUCTURED GRIDS

YANNIS KALLINDERIS (Texas, University, Austin) AIAA Journal (ISSN 0001-1452), vol. 30, March 1992, p. 631-639. Research supported by USAF. refs

Copyright

Algebraic turbulence models are quite common in flow numerical simulations. This paper presents a novel method of implementing an algebraic turbulence model with embedded, unstructured grids. The Baldwin-Lomax model was chosen in order to test the implementation. Modifications to the application of the original model on structured grids are suggested as well. Comparisons with both experiments and other numerical simulations are employed in order to evaluate accuracy of the implementation method. Author

A92-28035

FINITE ELEMENT NAVIER-STOKES SOLVER FOR UNSTRUCTURED GRIDS

D. L. MARCUM and R. K. AGARWAL (McDonnell Douglas Research Laboratories, Saint Louis, MO) AIAA Journal (ISSN 0001-1452), vol. 30, March 1992, p. 648-654. Research supported by McDonnell Douglas Corp. Previously cited in issue 16, p. 2486, Accession no. A90-38780. refs

Copyright

A92-28063* National Aeronautics and Space Administration, Washington, DC.

SKIN-FRICTION GAUGE FOR USE IN HYPERVELOCITY IMPULSE FACILITIES

G. M. KELLY, J. M. SIMMONS, and A. PAULL (Queensland, University, St. Lucia, Australia) AIAA Journal (ISSN 0001-1452), vol. 30, March 1992, p. 844, 845. Research supported by Australian Research Council. refs

(Contract NAGW-674)

Copyright

A transducer is presented which can measure as rise-time of about 20 microsec, and is thereby applicable to measurements in the high-enthalpy flows associated with hypervelocity impulse facilities. Results are presented which demonstrate the effectiveness of the concept in the case of skin-friction measurements conducted on a flat plate at Mach 3.2. The calibration used was against theoretical skin-friction values in a simple flow. O.C.

A92-28201*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

EULER SOLUTIONS FOR AN UNBLADED JET ENGINE CONFIGURATION

MARK E. M. STEWART (NASA, Lewis Research Center, Cleveland, OH) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 8 p. Previously announced in STAR as N92-11328. refs

(AIAA PAPER 92-0544)

An Euler solution for an axisymmetric jet engine configuration without blade effects is presented. The Euler equations are solved on a multiblock grid which covers a domain including the inlet, bybass duct, core passage, nozzle, and the far field surrounding the engine. The simulation is verified by considering five theoretical properties of the solution. The solution demonstrates both multiblock grid generation techniques and a foundation for a full jet engine throughflow calculation. Author

A92-28226*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

MODEL ATTITUDE MEASUREMENTS AT NASA LANGLEY RESEARCH CENTER

TOM D. FINLEY and PING TCHENG (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 8 p. refs

(AIAA PAPER 92-0763) Copyright

This paper describes the predominant instrumentation used to make precision model attitude measurements in wind tunnel testing at NASA Langley Research Center (LaRC). It covers all aspects of precision model attitude measurements: the type of sensors, testing and calibration, packaging preparation, signal conditioning,

and user instructions. The paper concludes with descriptions of alternate methods to make precision model attitude measurements and future directions in this field. Author

A92-28464
COMPUTATIONAL MECHANICS TODAY
O. C. ZIENKIEWICZ (Swansea, University College, Wales) (World Congress on Computational Mechanics, 2nd, Stuttgart, Federal Republic of Germany, Aug. 27-31, 1990, Selected Papers. Pt. 1. A92-28463 10-39) International Journal for Numerical Methods in Engineering (ISSN 0029-5981), vol. 34, March 15, 1992, p. 9-33. refs
Copyright
Recent progress in computational mechanics is reviewed, stressing the essential unity of the subject and examining areas where progress and research are currently active. Emphasis is given to adaptive error-controlled analysis and treatment of hyperbolic problems. C.D.

A92-28495
PAINT UNDER PRESSURE
RICHARD DEMEIS Aerospace America (ISSN 0740-722X), vol. 30, March 1992, p. 40, 41.
Copyright
A class of paints is described which can be employed to indicate the static air pressure being exerted on them, and reference is given to the developmental status of the coatings. The paints are based on the use of 'probe' molecules that fluoresce when excited by distinct light frequencies, and the sensitivities of the paints are described with reference to test results. The coatings can be employed to reduce the costs of wind-tunnel and flight tests by rendering redundant the currently used networks of taps and transducers. C.C.S.

A92-28513
SWIRL EFFECTS ON CONFINED FLOWS IN AXISYMMETRIC GEOMETRIES
S. A. AHMED and A. S. NEJAD (USAF, Aero Propulsion and Power Laboratory, Wright-Patterson AFB, OH) (International Congress of Fluid Mechanics, 3rd, Cairo, Egypt, Jan. 2-4, 1990, Proceedings. Vol. 1, p. 359-370) Journal of Propulsion and Power (ISSN 0748-4658), vol. 8, Mar.-Apr. 1992, p. 339-345. Research supported by USAF. Previously cited in issue 21, p. 3367, Accession no. A90-46855. refs

A92-28528
HIGH-TEMPERATURE POWDER-LUBRICATED DAMPERS FOR GAS TURBINE ENGINES
H. HESHMAT and J. F. WALTON (Mechanical Technology, Inc., Latham, NY) Journal of Propulsion and Power (ISSN 0748-4658), vol. 8, Mar.-Apr. 1992, p. 449-456. Research sponsored by USAF. Previously cited in issue 18, p. 2896, Accession no. A90-41999. refs
Copyright

A92-28529
COMPUTATIONAL STUDIES OF A SUPERDETONATIVE RAM ACCELERATOR MODE
S. YUNGSTER and A. P. BRUCKNER (Washington, University, Seattle) Journal of Propulsion and Power (ISSN 0748-4658), vol. 8, Mar.-Apr. 1992, p. 457-463. Research supported by Olin Corp. Previously cited in issue 20, p. 3152, Accession no. A89-47007. refs
(Contract N00014-88-K-0565)
Copyright

A92-28537* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
UNSTEADY ANALYSIS OF HOT STREAK MIGRATION IN A TURBINE STAGE
DANIEL J. DORNEY, ROGER L. DAVIS, DAVID E. EDWARDS (United Technologies Research Center, East Hartford, CT), and NATERI K. MADAVAN (NASA, Ames Research Center, Moffett Field, CA) Journal of Propulsion and Power (ISSN 0748-4658), vol. 8, Mar.-Apr. 1992, p. 520-529. Research sponsored by United Technologies Corp. Previously cited in issue 19, p. 3046, Accession no. A90-42782. refs
(Contract N00014-88-C-0677)
Copyright

N92-18053*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EFFECT OF CRASH PULSE SHAPE ON SEAT STROKE REQUIREMENTS FOR LIMITING LOADS ON OCCUPANTS OF AIRCRAFT
HUEY D. CARDEN Washington Feb. 1992 23 p
(NASA-TP-3126; L-16941; NAS 1.60:3126) Avail: NTIS HC/MF A03 CSCL 20/11
An analytical study was made to provide comparative information on various crash pulse shapes that potentially could be used to test seats under conditions included in Federal Regulations Part 23 Paragraph 23.562(b)(1) for dynamic testing of general aviation seats, show the effects that crash pulse shape can have on the seat stroke requirements necessary to maintain a specified limit loading on the seat/occupant during crash pulse loadings, compare results from certain analytical model pulses with approximations of actual crash pulses, and compare analytical seat results with experimental airplace crash data. Structural and seat/occupant displacement equations in terms of the maximum deceleration, velocity change, limit seat pan load, and pulse time for five potentially useful pulse shapes were derived; from these, analytical seat stroke data were obtained for conditions as specified in Federal Regulations Part 23 Paragraph 23.562(b)(1) for dynamic testing of general aviation seats. Author

N92-18091 ESDU International Ltd., London (England).
RESPONSE OF STRUCTURES TO GALLOPING EXCITATION: BACKGROUND AND APPROXIMATE ESTIMATION
Dec. 1991 24 p
(ESDU-91010; ISBN-0-85679-772-3; ISSN-0141-2702) Avail: ESDU
Described here is the mechanism of galloping, an aeroelastic response in which changes in wind load due to structure response are in-phase with the structure velocity. The concepts of soft and hard oscillators are introduced and explained, and the possibilities of across-wind, along-wind and torsional galloping are discussed. Stall galloping, wake galloping, and flutter as separate mechanisms are defined and briefly described. A method is provided for estimating the wind speed for the onset of galloping (or the structural damping required to prevent galloping at a given wind speed) for a single degree of freedom system. A technique of approximately determining the galloping onset wind speed and the maximum amplitude is suggested for force coefficient curves typical of sharp-edged sections. Typical results for onset wind speed and response are shown for typical force curves. The theoretical approach used is fully explained and a worked example illustrates its use. Methods of reducing or eliminating galloping are outlined briefly. ESDU

N92-18116# Wichita State Univ., KS. National Inst. for Aviation Research.
EXAMINATION OF ENERGY SPECTRA MOMENTS IN A DEVELOPING TURBULENT FLOW
JULIE A. MATHIS Dec. 1991 20 p
(NIAR-91-28) Avail: NTIS HC/MF A03
Velocity measurements are made in a turbulent developing flow. The experiment is performed in a wind tunnel and consists of a jet ejecting normally into a confined cross stream. Measurements are made by laser velocimetry, with the data sampled and recorded at a high enough rate to allow characterizations of the turbulent fine scales (38,000 sec(exp -1)). Kolmogorov-normalized energy spectra and their moments are constructed, and examined for micro-scale Reynolds number dependence. The data reveals a very well correlated logarithmic relationship between the peak values of moments of the normalized energy spectra and the microstructure Reynolds number. Author

N92-18120 Department of the Navy, Washington, DC.
SINGLE SCREW MECHANISM WITH GATEROTOR HOUSING AT INTERMEDIATE PRESSURE Patent
DAVID C. WINYARD, inventor (to Navy) 28 May 1991 11 p
Filed 31 May 1989
(AD-D015140; US-PATENT-5,018,952;
US-PATENT-APPL-SN-359462) Avail: US Patent and Trademark Office CSCL 13/7

This patent discloses an invention that is an improvement upon conventional single-screw mechanisms in that the gaterotor housing is substantially isolated from both the inlet and outlet port areas by a window opening path through the casing whereby the gaterotor teeth pass for engagement with the mainrotor. The window path has been extended and has close clearances provided on both sides of the entering gaterotor teeth creating two barriers to internal leakage thereby reducing window path losses, increasing volumetric efficiency, and allowing higher pressure capability. GRA

N92-18187# Department of the Navy, Washington, DC.
AIR CUSHION VEHICLE CONDUCTIVE/SEMICONDUCTIVE FLEXIBLE SKIRT, AND METHOD Patent Application
RICHARD A. CAVENAGH, inventor (to Navy) and RAYMOND W. DYKE, inventor (to Navy) 2 Mar. 1990 14 p
(AD-D015160; US-PATENT-APPL-SN-487489) Avail: NTIS HC/MF A02

Discussed here is a method for dissipating static electrical energy from air cushion vehicles when operating more particularly in cold, low humidity environments, which method involves fabricating the skirt assembly from a flexible sheet material of at least semiconductive character, which will provide a suitable dissipating grounding pathway to discharge potential static electrical energy generated during the aforesaid operation. The method includes using a coated flexible fabric material having at least one of its opposite surfaces coated with an elastomeric abrasion-resistant material, and embedding a plurality of electrically conductive flexible strands at least partially within said flexible fabric material, or alternatively embedding electrically conductive particles or fibers in a generally uniformly manner throughout a forming of its elastomeric composition. The invention also is directed specifically to/on an air cushion vehicle skirt component comprised of electrically conductive composite flexible sheet material having sufficient conductive characteristics to provide a near constant dissipation grounding pathway from said vehicle for any substantial build up of generated static electrical energy, more particularly when the air cushion vehicle is operating in cold, low humidity environments. GRA

N92-18221# National Aerospace Lab., Amsterdam (Netherlands). Fluids Div.
CAR 88: A METHOD TO CALCULATE SUBSONIC AND SUPERSONIC, STEADY AND UNSTEADY, POTENTIAL FLOW ABOUT COMPLEX CONFIGURATIONS
M. H. L. HOUNJET 7 Oct. 1988 75 p Sponsored in part by Royal Netherlands Air Force
(NLR-TR-88154-U; ETN-92-90956) Avail: NTIS HC/MF A04

A description of the method CAR88 for the calculation of steady and time linearized unsteady subsonic and supersonic flow about complex two dimensional and three dimensional configurations is given. The method belongs to the category of the so called panel methods. Results of applications in supersonic flow made to a two dimensional oscillating flat plate, a two dimensional double and single edge airfoil, three dimensional cones, and to single and multiple interfering wing surface are shown. ESA

N92-18244# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Goettingen (Germany, F.R.).
INSTITUTE FOR EXPERIMENTAL FLUID MECHANICS: RESULTS FOR 1990 [INSTITUT FUER EXPERIMENTELLE STROEMUNGSMECHANIK ERGEBNISSE 1990]
T. GREEN-THOMAS Jul. 1991 152 p In GERMAN
(IB-222-90-A-46) Avail: NTIS HC/MF A08

Summaries are presented for areas of research at the Institute. The departments represented include the Dept. of Measurement Physics, Dept. of Boundary Layer and Subsonic Flow, Dept. of Lattice Flow, Dept. of High Speed Flow, and the Dept. of Rarefied and Real Gas Flow. Some of the programs are as follows: commercial aircraft technologies; military aircraft and aircraft structures technology; turbine aircraft engine technologies; simulations and design fundamentals; hypersonic and reentry technologies; and orbital technologies. E.R.

N92-18317# Manchester Univ. (England). Aeronautical Engineering Group.
PROPAGATION OF SHOCK WAVES THROUGH CLOUDS Ph.D. Thesis
XIN XIN ZHOU Oct. 1990 150 p
(AERO-REPT-9104; ETN-92-90935) Avail: NTIS HC/MF A07

The behavior of a shock wave propagating into a cloud consisting of an inert gas, water vapor and water droplets was investigated. This has particular application to sonic bangs propagating in the atmosphere. The finite different method of MacCormack is extended to solve the one and two dimensional, two phase flow problems in which mass, momentum and energy transfers are included. The FCT (Fluid Corrected Transport) technique developed by Boris and Book was used in the basic numerical scheme as a powerful corrective procedure. The results for the transmitted shock waves propagating in a one dimensional, semi infinite cloud obtained by the finite difference approach are in good agreement with previous results by Kao using the method characteristics. The advantage of the finite difference method is its adaptability to two and three dimensional problems. Shock wave propagation through a finite cloud and into an expansion with a 90 degree corner was investigated. It was found that the transfer processes between the two phases in two dimensional flow are much more complicated than in the one dimensional flow cases. This is mainly due to the vortex and expansion wave generated at the corner. In the case considered, further complications were generated by the reflected shock wave from the floor. Good agreement with experiment was found for one phase flow but experimental data for the two phase case is not yet available to validate the two phase calculations. ESA

N92-18483# National Aerospace Lab., Tokyo (Japan). Aircraft Aerodynamics Div.
PROCEEDINGS OF THE SEMINAR ON INVESTIGATION AND CONTROL OF BOUNDARY-LAYER TRANSITION [KYOKAISO SENI NO KAIMEI TO SEIGYO KENKYUKAI KOENSHU]
NOBUTAKE ITO, MICHIO NISHIOKA, KIYOSHI YAMAMOTO, YASUAKI KOHAMA, NAOKI HIROSE, YOJI ISHIDA, MICHIO OJI, SHOHEI TAKAGI, AKIRA ITO (Meiji Univ., Kawasaki, Japan), ICHIRO TANI et al. Jan. 1990 68 p In JAPANESE Seminars held from Sep. 1987 - Feb. 1989
(NAL-SP-11; ISSN-0289-260X; JTN-92-80287) Avail: NTIS HC/MF A04

This report is a proceeding of 22 lectures presented at the study meeting on the Investigation and Control of Boundary-Layer Transition held four times from September 1987 to February 1989. It contains reports on the analysis of transition mechanism, three-dimensional boundary-layer transition, transition control, and other topics. This group consists of researchers participating in applications research for fundamental studies on boundary layer transition, with the aim of exchanging their opinions and discussing them thoroughly. Recently, lectures and discussions have been ranging over more subjects including not only transition problems but also analysis of turbulence flows and control methods to reduce viscous resistance. Author (NASDA)

N92-18485# National Aerospace Lab., Tokyo (Japan). Airframe Div.
VIBRATION TESTS OF LONG PLATE STRUCTURAL MODEL [OBIITA KOZO MOKEI NO SHINDO SHIKEN]
YASUKATSU ANDO, MASAKATSU MINEGISHI, YUJI MATSUZAKI, and KUNIO KUMAKURA Jul. 1990 33 p In JAPANESE
(NAL-TM-625; ISSN-0452-2982; JTN-92-80293) Avail: NTIS HC/MF A03

In order to establish a test method of the sine wave multipoint

forced oscillation test, the vibration test using the multipoint forced oscillation analysis system of the vibration test facility was performed. As the analysis method, the normal mode method (MODAP) and the transfer function method by forced oscillation (MODAT SINE) were adopted. As the test model in the test, long plate structure mode was made. As a result of the test, technical experience of the vibration test using large structures was accumulated and problems to be solved in the future were identified. Author (NASDA)

N92-18515# Vatell Corp., Blacksburg, VA.
EDDY CURRENT TRANSDUCING SYSTEM
13 Sep. 1991 77 p
(Contract DE-FG01-89CE-15426)
(DE91-018924; DOE/CE-15426/T9) Avail: NTIS HC/MF A05

In a program funded by the Office of Energy Related Inventions of the Department of Energy, Vatell Corporation developed a prototype Turbine Blade Condition Monitor. This microcomputer-based system was tested to determine its performance in measuring individual blade clearance and time of arrival on a Pratt & Whitney (Canada) JT15D jet engine. A Vatell eddy current sensor mounted in the housing of the engine at mid-chord of the N1 first stage provided the signals. The N1 first stage is a 31 in. diameter fan with 28 titanium blades, operating over a speed range of approximately 7000 to 14,000 rpm. Tests showed that the monitoring system transduced blade clearances with a precision of .0001 in., simultaneously indicating times of arrival within 0.1 microseconds, equivalent to a pitch of .0015 in. Patterns of blade clearances and timing variations were observed for various engine operating conditions, and the clearance and time of arrival 'signatures' of the fan stage were recorded. Manufacturing variations in blade pitch were readily detected, as were indications of blade and hub vibration. The report contains a detailed description of the development program, examples of waveforms and recorded data, circuit diagrams, software, setup, and operating procedures for the monitoring system. DOE

N92-18550# Oak Ridge National Lab., TN.
COUNTERROTATING BRUSHLESS DC PERMANENT MAGNET MOTOR Patent Application
R. A. HAWSEY, inventor (to DOE) and J. M. BAILEY, inventor (to DOE) 30 Jul. 1990 13 p
(Contract DE-AC05-84OR-21400)
(DE92-003825; US-PATENT-APPL-SN-559030;
PATENTS-US-A7559030) Avail: NTIS HC/MF A03

A brushless DC permanent magnet motor is provided for driving an autonomous underwater vehicle. In one embodiment, the motor comprises four substantially flat stators disposed in stacked relationship, with pairs of the stators being axially spaced and each of the stators comprising a tape-wound stator coil; first and second substantially flat rotors disposed between the spaced pairs of stators. Each of the rotors includes an annular array of embedded permanent magnets. A first shaft is connected to the first rotor and a second, concentric shaft is connected to the second rotor, and the drive unit causes rotation of the two shafts in opposite directions. The second shaft comprises a hollow tube having a central bore in which the first shaft is disposed. Two different sets of bearings support the first and second shafts. In another embodiment, the motor comprises two ironless stators and pairs, and rotors mounted on opposite sides of the stators and driven by counterrotating shafts. DOE

N92-18573# Centre d'Essais Aeronautique Toulouse (France). Div. Materiaux et Structures.
FATIGUE SAFETY FACTOR: ASSESSMENT OF ASSOCIATED SAFETY LEVEL
V. DEHAYE *In* AGARD, Fatigue Management 5 p Dec. 1991
In FRENCH
Copyright Avail: NTIS HC/MF A12; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Techniques related to the determination of fatigue reliability factors for aircraft structures are discussed. Particular attention is given to methods for the estimation of corresponding safety levels. Of central concern are those combat aircraft that have been reviewed according to the 'safe life' concept. The parameters affecting structural fatigue behavior are outlined. Approaches to fatigue reliability analysis used for the principle french combat fleet are addressed. Transl. by M.G.

N92-18705# Sandia National Labs., Albuquerque, NM.
METHOD AND APPARATUS FOR ACOUSTIC PLATE MODE LIQUID-SOLID PHASE TRANSITION DETECTION Patent Application
D. S. BLAIR, inventor (to DOE), G. C. FRYE, inventor (to DOE), R. C. HUGHES, inventor (to DOE), S. J. MARTIN, inventor (to DOE), and A. J. RICCO, inventor (to DOE) 31 May 1990 19 p
(Contract DE-AC04-76DP-00789)
(DE92-003778; US-PATENT-APPL-SN-531492;
PATENTS-US-A7531492) Avail: NTIS HC/MF A03

A method and apparatus for sensing a liquid-solid phase transition event is provided which comprises an acoustic plate mode detecting element placed in contact with a liquid or solid material which generates a high-frequency acoustic wave that is attenuated to an extent based on the physical state of the material in contact with the detecting element. The attenuation caused by the material in contact with the acoustic plate mode detecting element is used to determine the physical state of the material being detected. The method and device are particularly suited for detecting conditions such as the icing and deicing of wings of an aircraft. In another aspect of the present invention, a method is provided wherein the adhesion of a solid material to the detecting element can be measured using the apparatus of the invention. DOE

N92-18877*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
THERMAL/STRUCTURAL ANALYSIS OF A TRANSPIRATION COOLED NOZZLE
PEYTON B. GREGORY, JON E. THOMPSON, DALE A. BABCOCK, CARL E. GRAY, JR., and CHRIS A. MOURING Feb. 1992 33 p
(NASA-TM-104184; NAS 1.15:104184) Avail: NTIS HC/MF A03 CSCL 20/11

The 8-foot High Temperature Tunnel (HTT) at LaRC is a combustion driven, high enthalpy blow down wind tunnel. In Mar. 1991, during check out of the transpiration cooled nozzle, pieces of platelets were found in the tunnel test section. It was determined that incorrect tolerancing between the platelets and the housing was the primary cause of the platelet failure. An analysis was performed to determine the tolerance layout between the platelets and the housing to meet the structural and performance criteria under a range of thermal, pressure, and bolt preload conditions. Three recommendations resulted as a product of this analysis. Author

N92-18897# Efratom Systems Corp., Irvine, CA.
TACTICAL RUBIDIUM FREQUENCY STANDARD (TRFS) Final Technical Report, Nov. 1983 - Oct. 1989
WERNER WEIDEMANN, WILLIAM CASHIN, and THOMAS ENGLISH Sep. 1991 114 p LIMITED REPRODUCIBILITY: Availability: Document partially illegible
(Contract F19628-83-C-0173)
(AD-A243934; RL-TR-91-245) Avail: NTIS HC/MF A06 CSCL 14/2

This report describes the accomplishments of a six-year R&D progress to design, build, and evaluate three Tactical Rubidium Frequency Standards (TRFS) units for the Air Force. The TRFS is a miniature atomic time and frequency source that can operate in a harsh, tactical military environment. The TRFS design must incorporate significant advances in miniaturization, ruggedness, fast warmup, and high-temperature operation required for aircraft operations. This report includes a detailed description of the TRFS design as developed at Efratom, the results of qualification tests on three TRFS units, and part reliability data obtained over the course of the contract. Author (GRA)

N92-18933# Imperial Coll. of Science and Technology, London (England).
THE 8TH SYMPOSIUM ON TURBULENT SHEAR FLOWS. VOLUME 1: SESSIONS 1-18
Sep. 1991 522 p Symposium held in Munich, Fed. Republic of Germany, 9-11 Sep. 1991
(Contract DAJA45-91-M-0079)
(AD-A243809; R/D-6662-AN-02) Avail: NTIS HC/MF A22
CSCL 20/4

Session topics in this volume include wall flow, mixing layers, free shear flow, two phase flow, aerodynamic flow, unsteady flow, atmospheric flow, applications, separated flow, transition, homogenous flow, and transition and control. GRA

N92-18940# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
INVESTIGATION OF THE EFFECTS OF AEROELASTIC DEFORMATIONS ON THE RADAR CROSS SECTION OF AIRCRAFT M.S. Thesis
SAMUEL D. MCKENZIE Dec. 1991 133 p
(AD-A243889; AFIT/GE/ENG/91D-40) Avail: NTIS HC/MF A07
CSCL 17/9

The effects of aeroelastic deformations on the radar cross section (RCS) of a T-38 trainer jet and a C-5A transport aircraft are examined and characterized. Realistic representations of structural wing deformations are obtained from a mechanical/computer aided design software package called NASTRAN. NASTRAN is used to evaluate the structural parameters of the aircraft as well as the restraints and loads associated with realistic flight conditions. Geometries for both the non-deformed and deformed airframes are obtained from the NASTRAN models and translated into RCS models. The RCS is analyzed using a numerical modeling code called the Radar Cross Section - Basic Scattering Code, version 2 which was developed at the Ohio State University and is based on the uniform geometric theory of diffraction. The code is used to analyze the effects of aeroelastic deformations on the RCS of the aircraft by comparing the computed RCS representing the deformed airframe to that of the non-deformed airframe and characterizing the differences between them. GRA

N92-18959# Federal Aviation Administration, Atlantic City, NJ.
HIGH CAPACITY VOICE RECORDER (HCVR) OPERATIONAL TEST AND EVALUATION (OT AND E)/INTEGRATION TEST PLAN
WAYNE E. BELL, ANDY COLON, and EDWARD LIND Feb. 1992 58 p
(DOT/FAA/CT-TN91/55) Avail: NTIS HC/MF A04

This plan addresses the Operational Test and Evaluation (OT&E)/Integration testing of the High Capacity Voice Recorder (HCVR) equipment in the current NAS environment. The approach and concept is to conduct integration tests with appropriate National Airspace System (NAS) subsystem to verify that NAS requirements and HCVR Purchase Description (PD) requirements have been satisfied. This will be accomplished by conducting unit level tests at the FAA Technical Center and extensive integration tests at Seattle Air Route Traffic Control Center (ARTCC). Author

N92-18965*# Institute for Computer Applications in Science and Engineering, Hampton, VA.
NUMERICAL SIMULATION OF TRANSIENT HYPERVELOCITY FLOW IN AN EXPANSION TUBE Final Report
P. A. JACOBS Jan. 1992 58 p
(Contract NAS1-18605)
(NASA-CR-189601; NAS 1.26:189601; ICASE-IR-20) Avail: NTIS HC/MF A04 CSCL 20/4

Several numerical simulations of the transient flow of helium in an expansion tube are presented. The aim of the exercise is to provide further information on the operational problems of the NASA Langley expansion tube. The calculations were performed with an axisymmetric Navier-Stokes code based on a finite-volume formulation and upwinding techniques. Although laminar flow and ideal bursting of the diaphragms was assumed, the simulations showed some of the important features seen in the experiments. In particular, the discontinuity in the tube diameter at the primary diaphragm station introduced a transverse perturbation to the expanding driver gas, and this perturbation was seen to propagate into the test gas under some flow conditions. The disturbances seen in the test flow can be characterized as either 'small-amplitude' noise possibly introduced during shock compression or 'large-amplitude' noise associated with the passage of the reflected head of the unsteady expansion. Author

N92-18971*# General Electric Co., Cincinnati, OH. Aircraft Engines.
THE 3D INELASTIC ANALYSIS METHODS FOR HOT SECTION COMPONENTS Final Report
R. L. MCKNIGHT, R. J. MAFFEO, M. T. TIPTON, and G. WEBER Jan. 1992 179 p
(Contract NAS3-23698)
(NASA-CR-189089; NAS 1.26:189089) Avail: NTIS HC/MF A09
CSCL 20/11

A two-year program to develop advanced 3D inelastic structural stress analysis methods and solution strategies for more accurate and cost effective analysis of combustors, turbine blades, and vanes is described. The approach was to develop a matrix of formulation elements and constitutive models. Three constitutive models were developed in conjunction with optimized iterating techniques, accelerators, and convergence criteria within a framework of dynamic time incrementing. Three formulation models were developed: an eight-noded midsurface shell element; a nine-noded midsurface shell element; and a twenty-noded isoparametric solid element. A separate computer program has been developed for each combination of constitutive model-formulation model. Each program provides a functional stand alone capability for performing cyclic nonlinear structural analysis. In addition, the analysis capabilities incorporated into each program can be abstracted in subroutine form for incorporation into other codes or to form new combinations. Author

N92-19004# Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Structures and Materials Panel.
AGARD/SMP REVIEW: DAMAGE TOLERANCE FOR ENGINE STRUCTURES. 4: RELIABILITY AND QUALITY ASSURANCE
Dec. 1991 42 p In ENGLISH and FRENCH The 69th meeting was held in Brussels, Belgium, 1-6 Oct. 1989
(AGARD-R-773; ISBN-92-835-0648-0) Copyright Avail: NTIS HC/MF A03; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

The workshop reviewed the areas critical to the acceptance of an approach based on damage tolerance concepts as an alternative service life philosophy to that of 'safe life' for the design of engine components. Also addressed was the need for, and the approaches to, ensuring component reliability and quality assurance. The current procedures were surveyed for materials and component specifications, standard process control, quality assurance, and systems design.

N92-19005# Rolls-Royce Ltd., Derby (England).
INTRODUCTION: NEEDS AND APPROACHES TO RELIABILITY AND QUALITY ASSURANCE IN DESIGN AND MANUFACTURE
A. C. PICKARD *In* AGARD, AGARD/SMP Review: Damage Tolerance for Engine Structures. 4: Reliability and Quality Assurance 4 p Dec. 1991 Previously announced as N91-10297
Copyright Avail: NTIS HC/MF A03; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

In the damage tolerance approach for improving the integrity of aircraft engines, reliability and quality assurance issues are discussed. The implications of the following aspects on the damage tolerance concept are studied: component material specifications and standards; controls on manufacturing processes and procedures; and design systems and quality assurance. The subjects reviewed in the workshop on reliability and quality assurance are given. Author

N92-19006# Societe Nationale d'Etude et de Construction de Moteurs d'Aviation, Evry Cedex (France).
MANUFACTURING PROCESS CONTROL AS A DAMAGE TOLERANCE CONCEPT
JEAN-PAUL HERTEMAN *In* AGARD, AGARD/SMP Review: Damage Tolerance for Engine Structures. 4: Reliability and Quality Assurance 7 p Dec. 1991
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Manufacturing process control means a search for the lowest possible variability of the manufacturing part characteristics. Process control is as necessary for damage tolerance as for a conventional 'safe service life' design, or even more, for reasons relating to the engine reliability and operation safety on the one hand and to the life cycle costs on the other hand. These reasons are reviewed. Furthermore, damage tolerance contains several concepts which can be used profitably to modify, reorientate, and improve the procedures giving access to the required process control. Some of these concepts are discussed. Author

N92-19052# Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering.
NUMERICAL SOLUTION OF THREE-DIMENSIONAL UNSTEADY VISCOUS FLOWS Progress Report, 1 Jun. - 30 Nov. 1991
LAKSHMI N. SANKAR 30 Nov. 1991 22 p
(Contract N00014-89-J-1319)
(AD-A244274) Avail: NTIS HC/MF A03 CSCL 20/4

In many fluid dynamics problems, the flows are three-dimensional, unsteady and turbulent. Flow past submarine configurations, flow through marine propellers and turbomachinery are examples of such flows. Numerical procedures for accurate and efficient computations of such flows are presently not possible due to mixed elliptic-parabolic nature of the governing equations. Indeed, methods for 3-D incompressible flows lag behind 3-D compressible flows by several years. Until accurate and efficient methods for 3-D incompressible, unsteady flows become available, it will be possible to attempt challenging problems such as first principles based direct simulations of turbulent flow over marine vehicles. The long term objective of the present effort is the development of solution techniques for direct numerical simulation of unsteady 3-D incompressible turbulent flows. The kinetic aspects of this problem are governed by a set of parabolic partial differential equations, which may be efficiently integrated by a variety of time marching schemes. The kinematic aspects of this flow such as the relationship between velocity and vorticity, and the relationship between velocity and pressure are governed by elliptic partial differential equations, which can be solved at any instance in time, only by iterative techniques. GRA

N92-19080# Arnold Engineering Development Center, Arnold Air Force Station, TN.
ASYMPTOTIC THEORY OF TRANSONIC WIND TUNNEL WALL INTERFERENCE Final Report, 30 Mar. 1984 - 30 Jul. 1990
N. D. MALMUTH, C. C. WU, H. JAFROUDI, R. MCLACHLAN, and J. D. COLE Dec. 1991 230 p
(Contract F40600-84-C-0010)
(AD-A244075; AEDC-TR-91-24) Avail: NTIS HC/MF A11 CSCL 20/4

Two limiting cases are considered related to transonic wall interference. For the first case corresponding to slender airplanes, an area rule for interference holds in which the interference of the complete airplane can be obtained from that of its equivalent body of revolution. For large wall height, the slender case exhibits an asymptotic triple deck structure consisting of a cross flow-dominated zone near the model, a weakly perturbed free-field mid-field which has a linear multipole far field for solid and free-jet wall conditions. Nonclassical, experimentally determined pressure conditions prescribed on a cylindrical interface lead to a tube vortex far field. For a high aspect ratio second case, the interference is driven by the imaging effect of the interference on the projection of the trailing vortex system in the Trefftz plane. This gives a downwash correction to a near-field nonlinear lifting line flow. Slightly subsonic free stream conditions give a spike like interference flow field due to the shock movement for both limiting cases. Computer codes written to treat these cases, as well as the underlying numerical methods, are described. Approaches integrating the asymptotics with measurement to augment Wall Interference Assessment/Correction (WIAC) procedures are outlined. GRA

N92-19151# Alenia, Torino (Italy).
PARAMETRIC BICUBIC SPLINE AND CAD TOOLS FOR COMPLEX TARGETS SHAPE MODELLING IN PHYSICAL OPTICS RADAR CROSS SECTION PREDICTION
A. DELOGU and F. FURINI *In* AGARD, Target and Clutter Scattering and their Effects on Military Radar Performance 13 p Sep. 1991
Copyright Avail: NTIS HC/MF A15; Non-NATO Nationals requests available only from AGARD/Scientific Publications Executive

Increasing interest in radar cross section (RCS) reduction is placing new demands on theoretical, computation, and graphic techniques for calculating scattering properties of complex targets. In particular, computer codes capable of predicting the RCS of an entire aircraft at high frequency and of achieving RCS control with modest structural changes, are becoming of paramount importance in stealth design. A computer code, evaluating the RCS of arbitrary shaped metallic objects that are computer aided design (CAD) generated, and its validation with measurements carried out using ALENIA RCS test facilities are presented. The code, based on the physical optics method, is characterized by an efficient integration algorithm with error control, in order to contain the computer time within acceptable limits, and by an accurate parametric representation of the target surface in terms of bicubic splines. Author

N92-19154# Alberta Research Council, Edmonton (Canada). Environmental Research and Engineering Dept.
THE APPLICATION OF LATTICE-STRUCTURE ADAPTIVE FILTERS TO CLUTTER-SUPPRESSION FOR SCANNING RADAR
C. GIBSON *In* AGARD, Target and Clutter Scattering and their Effects on Military Radar Performance 10 p Sep. 1991
Sponsored in part by Natural Sciences and Engineering Research Council
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The use of an adaptive filter to enhance the detection of moving targets in the presence of clutter is described. The scanning and pulsing rates of a typical surveillance radar produce, within each resolution cell, a time-series of samples at a given range, resulting from the consecutive pulses. In the case of coherent radar, this time-series corresponds to the Doppler spectrum of that resolution cell, containing radial velocity information on both targets and clutter within the cell. An adaptive filter can be used to enhance the target signal over the clutter signal by matching the clutter spectrum, thus whitening the filter output, so that only the target's spectral components stand out. It is possible for the filter to discriminate between the clutter spectrum and the target spectrum because clutter is generally a diffuse source, spread over many adjacent cells, while the target is generally a point source, occupying a single cell. The adaptive digital-filtering structure examined was the lattice-structure prediction-error filter. A number of adaptation algorithms were examined for this structure, with the best results being obtained with the harmonic-mean algorithm. Within this algorithm, two gradient methods were examined for adaptation in a nonstationary environment. To test these algorithms and methods, coherent radar data was gathered from a 10 cm air traffic control surveillance radar. This data included different targets (aircraft and bird flocks) in a variety of clutter conditions (ground, rain, ice pellet, snow, and anomalous propagation clutter). Quantitative results are presented, including improvement factors and sub-clutter visibility factors, that show significantly better performance for these adaptive filters, when compared with conventional moving-target-indicator filters. Author

N92-19155# Aeritalia S.p.A., Rome (Italy).
USE OF TARGET SPECTRUM FOR DETECTION ENHANCEMENT AND IDENTIFICATION
S. PARDINI, P. F. PELLEGRINI (Florence Univ., Italy), and P. PICCINI *In* AGARD, Target and Clutter Scattering and their Effects on Military Radar Performance 12 p Sep. 1991
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Modulation on the echo signal generated by rotating machinery of an air target is addressed. An extensive measurement campain was carried out by means of an air traffic control radar and some preliminary results are presented. The problem of target spectra characterization and exploitation for detection enhancement and target identification, is considered in relation with the limitation imposed by the present radar features. Some considerations regarding the application of this technique for non-cooperative target recognition, in the radar of future generation, are developed. Author

N92-19183# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
THERMAL NONEQUILIBRIUM EFFECTS ON TURBINE CASCADE AERODYNAMICS M.S. Thesis
JILL L. SHAW Dec. 1991 70 p
(AD-A244049; AFIT/GAE/ENY/91D-25) Avail: NTIS HC/MF A04 CSCL 20/4

The AFIT Total Variation Diminishing Euler Code (ATEC) was modified to include a thermal nonequilibrium model to investigate high temperature effects associated with vibrational relaxation in a transonic turbine cascade. Incorporation of this model into ATEC and creating ANTEC (AFIT Nonequilibrium TVD Euler Code) was accomplished in three steps. Steady-state solutions obtained with ANTEC were compared with those obtained with ATEC for various inlet and exit conditions. The Courant-Friedrichs-Levy criterion was held constant to ATEC; however, it required variation for ANTEC. Blade temperature profiles, temperature difference contours in the vicinity of the trailing edge and the value of the ratio of specific heats (gamma) along the blade were analyzed. Even when corrected for high temperatures, the assumptions of a calorically perfect gas and thus a constant value of gamma are inaccurate due to the temperature dependent nature of specific heats at constant pressure and at constant value. Maximum temperature differences of -741 K and 539 K were found near the trailing edge for the highest temperature case, with differences being most noticeable through the expansion at the trailing edge on the pressure surface and across the shocks from both surfaces. The vibrational relaxation model showed limitations at low temperatures. GRA

N92-19217*# Ohio State Univ., Columbus. ElectroScience Lab.
ANALYSIS OF LOSSY COMPOSITE TERMINATING STRUCTURES
R. ANDRE, A. DOMINEK, J. MUNK, and N. WANG Sep. 1991 69 p
(Contract NAG3-1000)
(NASA-CR-189901; NAS 1.26:189901; TR-723224-3) Avail: NTIS HC/MF A04 CSCL 20/14

A finite element solution and computer code for the electromagnetic scattering of inhomogeneous penetrable bodies is presented. The application for the code is for the analysis and design of leading and trailing edge terminations when conducting and nonconducting materials are used. Examples of simple triangular shaped terminations are also presented. Author

N92-19258*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
EXPERIMENTAL VALIDATION OF STRUCTURAL OPTIMIZATION METHODS
HOWARD M. ADELMAN Jan. 1992 36 p
(NASA-TM-104203; NAS 1.15:104203) Avail: NTIS HC/MF A03 CSCL 20/11

The topic of validating structural optimization methods by use of experimental results is addressed. The need for validating the methods as a way of effecting a greater and an accelerated acceptance of formal optimization methods by practicing engineering designers is described. The range of validation strategies is defined which includes comparison of optimization results with more traditional design approaches, establishing the accuracy of analyses used, and finally experimental validation of the optimization results. Examples of the use of experimental results to validate optimization techniques are described. The examples include experimental validation of the following: optimum design of a trussed beam; combined control-structure design of a cable-supported beam simulating an actively controlled space structure; minimum weight design of a beam with frequency constraints; minimization of the vibration response of helicopter rotor blade; minimum weight design of a turbine blade disk; aeroelastic optimization of an aircraft vertical fin; airfoil shape optimization for drag minimization; optimization of the shape of a hole in a plate for stress minimization; optimization to minimize beam dynamic response; and structural optimization of a low vibration helicopter rotor. Author

N92-19277*# General Electric Co., Cincinnati, OH. Aircraft Engine Business Group.
ENGINE STRUCTURES MODELING SOFTWARE SYSTEM (ESMOSS) Final Report
Oct. 1991 84 p
(Contract NAS3-22767)
(NASA-CR-187227; NAS 1.26:187227) Avail: NTIS HC/MF A05 CSCL 20/11

Engine Structures Modeling Software System (ESMOSS) is the development of a specialized software system for the construction of geometric descriptive and discrete analytical models of engine parts, components, and substructures which can be transferred to finite element analysis programs such as NASTRAN. The NASA Lewis Engine Structures Program is concerned with the development of technology for the rational structural design and analysis of advanced gas turbine engines with emphasis on advanced structural analysis, structural dynamics, structural aspects of aeroelasticity, and life prediction. Fundamental and common to all of these developments is the need for geometric and analytical model descriptions at various engine assembly levels which are generated using ESMOSS. Author

N92-19349# Metraflu, Ecully (France).
INHOMOGENEOUS TURBULENCE BEYOND SPECTRAL EQUILIBRIA: AERONAUTICAL APPLICATIONS Final Report [TURBULENCE NON-HOMOGENE HORS D'EQUILIBRE SPECTRAL: APPLICATIONS AERONAUTIQUES. RAPPORT FINAL]
JEAN-PIERRE BERTOGLIO and MARC MICHARD Dec. 1990 93 p In FRENCH
(Contract DRET-88-351)
(ETN-92-90867) Avail: NTIS HC/MF A05

A spectral model of inhomogeneous turbulence is proposed. The simplified model is based on closure at two homogeneous points. The terms of inhomogeneous transport are expressed by means of a model based on one point of closure. The model is included in a finite element calculation code. Applications of the method to enclosed flow in aeronautical situations are proposed. Direct numerical simulation is carried out as a means of validating the method. The feasibility of a reference experiment is considered. Initial application to aeronautic calculations is performed. ESA

N92-19384# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
FINITE ELEMENT ANALYSIS OF A RIVETED REPAIR ON A CURVED COMPOSITE PANEL M.S. Thesis
SCOTT A. HAMILTON Dec. 1991 118 p
(AD-A243916; AFIT/GAE/ENY/91D-3) Avail: NTIS HC/MF A06 CSCL 13/13

To analyze the current Aircraft Battle Damage Repair (ABDR) Techniques, a finite element model (FEM) of a curved composite panel with a center cutout section was developed and verified against previously obtained modal test results. The FEM was

modified using different methods to exhibit the effects of riveting on an aluminum patch to repair the section. The different methods were contrasted against each other and previously obtained modal test results. The panel, a (0/-45/+45/90) sub s layup of AS4/3501 graphite epoxy measuring 12 inches in height and 12.19 inches across its arc length with a 2 by 4 inch cutout at a 0, +45, -45, or 90 degree orientation was modeled using MSC/NASTRAN QUAD4 elements. The first repair modeling method used a mixture of the aluminum and composite panel properties to represent the overlap region of the patch. The second method used ELAS2 and CONM2 elements to model the rivets, and modeled the panel and the patch separately. GAP elements prevented the patch from deforming through the panel. For the mixed properties, the mode shapes agreed with experimental data at lower frequencies but were distorted at the higher ones and were regularly 5-25 percent high. Modeling the rivets individually produced matching mode shapes and frequencies regularly within 5 percent of experimental values. GRA

N92-19386# PEDA Corp., Palo Alto, CA.
ACCURATE, PRODUCTIVE AERODYNAMIC SIMULATION ON PATCHED MESH SYSTEMS Final Report, 1 Oct. 1986 - 30 Sep. 1991
CHARLES LOMBARD 18 Oct. 1991 52 p
(Contract F49620-85-C-0081)
(AD-A243977; AFOSR-91-0975TR) Avail: NTIS HC/MF A04 CSCL 20/4

In the fifth and final year of the program the research has completed defining data structures, object based programming style, and tools for a new flexible approach to scientific programming and problem solving. Problems of program complexity associated with changing models and physics as well as with joined and disjoint multiple independent patched mesh domain decompositions for treating complex geometries and resolving captured flow structures can by systematically organized within the context of the directed graph programming concept being explored. Problems and parts of problems having geometric connectivity or its analogs such as association, hierarchy or precedence relationships are naturally exhibited and easily debugged or modified in the graph. The solution of problems is literally to traverse the graphs. For the emerging prototype aerodynamic simulation facility, the graphs which are to control grid generation Navier-Stokes solution procedures, and scientific graphics are to be constructed with a graphical editor hosted in high performance graphics workstations. The efficient global data structure for the system is a set of large linear arrays in which the data and parameterization associated with the independent quadrilateral blocks of mesh are sequentially stacked. The directed graph is to control procedures that point to and operate on the data structure. GRA

N92-19490# National Aerospace Lab., Amsterdam (Netherlands). Informatics Div.
WP 4B COMPRESSIBLE FLOW SIMULATION: INFORMATION SYSTEM FOR FLOW SIMULATION BASED ON THE NAVIER-STOKES EQUATION (ISNAS). REQUIREMENTS GRID GENERATION FOR THE ISNAS COMPRESSIBLE FLOW SOLVER
M. E. S. VOGELS 5 Apr. 1988 22 p
(NLR-TR-88103-U; ISNAS-88-05-028; ETN-92-90953) Avail: NTIS HC/MF A03

ISNaS will eventally consist of the subsystems geometry handling, grid generation, flow solver, and post processing (e.g., flow visualization). The requirements for subsystem grid generation for the ISNaS project flow solver are given. Since the development of the subsystem grid generation is not part of the ISNaS project, and existing subsystems will be used 'as is', restriction was made to the requirements essential for the generation of a suitable grid for viscous compressible flow simulation. ESA

N92-19538 California Inst. of Tech., Pasadena.
AN ANALYTICAL AND COMPUTATIONAL INVESTIGATION OF SHOCK-INDUCED VORTICAL FLOWS WITH APPLICATIONS TO SUPERSONIC COMBUSTION Ph.D. Thesis
JOSEPH YANG 1991 365 p
Avail: Univ. Microfilms Order No. DA9137305

The motivation for study of shock-induced vortical flows is the problem of achieving rapid and efficient mixing of fuel and oxidizer in a supersonic combustion ramjet engine. In particular, the interaction of a shock wave with a jet of light gas generates vorticity which can be used to stir and mix the fluids. This investigation consists of two parts. The first part is a characterization of the basic fluid mechanics of the interaction. The canonical problem is a shock wave passing over a circular light gas inhomogeneity to deposit vorticity around the perimeter. As time goes on, the structure rolls up into a pair of counter-rotating vortices. This flow is simulated numerically by integrating the governing equations subject to specified initial conditions. From first principles, analytical models are developed to predict the circulation, spacing, and characteristic time for development as a function of initial conditions. From perturbation analysis, another model is developed to predict the vortex pair velocity as a function of the geometrical parameters, vortex size/vortex spacing, and vortex spacing/channel spacing. The second part is an investigation of mixing efficiencies for various initial configurations. In the canonical flow, stabilization of the vortex pair eventually impairs the mixing. Various initial configurations are considered with the goal of improving the mixing. The mixing is quantified by an asymptotic stretching rate of a material element. Single jet shape perturbations yield little improvement in mixing, but multiple jet arrays do, especially through the phenomenon of entrainment. Another way to improve the mixing is to hit a vortex pair with a reflected shock. Finally, a mathematical correspondence is exhibited between the unsteady 2-D flows considered here and the corresponding 3-D steady flows that may be more typical of real combustor designs. Dissert. Abstr.

N92-19596*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.
LASER-SPECTROSCOPIC MEASUREMENT TECHNIQUES FOR HYPERSONIC, TURBULENT WIND TUNNEL FLOWS
ROBERT L. MCKENZIE and DOUGLAS G. FLETCHER Mar. 1992 13 p
(NASA-TM-103928; A-92076; NAS 1.15:103928) Avail: NTIS HC/MF A03 CSCL 14/2

A review is given of the nature, present status, and capabilities of two laser spectroscopic methods for the simultaneous measurement of temperature, density, and their fluctuations owing to turbulence in high speed wind tunnel flows. One method is based on the two frequency excitation of nitric oxide seeded into a nitrogen flow, using tunable dye lasers. The second, more recent method relies on the excitation of oxygen in air flows using a tunable, ArF excimer laser. Signal are obtained from both the laser induced fluorescence and from Raman scattering of the same laser pulse. Measurements are demonstrated in the turbulent boundary layer of a Mach-2 channel flow. Author

N92-19764# Electroimpact, Inc., Seattle, WA.
SUPPRESSION OF RADIATING HARMONICS ELECTRO-IMPULSE DEICING (EIDI) SYSTEMS
PETER ZIEVE, JAMES NG, and ROBERT FIEDBERG Oct. 1991 33 p
(Contract DTFA03-89-P-00692)
(DOT/FAA/CT-TN90/33) Avail: NTIS HC/MF A03

The electromagnetic compatibility (EMC) of two different configurations of electromagnetic deicing systems is discussed. Both Electro-Impulse Deicing (EIDI) and Eddy Current Repulsion Deicing Strip (EDS) are investigated. With EIDI, rigid coils are mounted behind the wing; while with EDS, the impulse coils are built thin and flexible with printed circuit board technology. An important consideration in the certification of electromagnetic impulse deicing systems is electromagnetic compatibility (EMC). When the capacitor bank discharges, a large current pulse travels

down a transmission line to the coil. The coil is one source of radiation. Another source is the cabling and connections to the coil. In work conducted for the FAA in 1988, it was found that excessive electromagnetic emissions resulted from the operation of a Low Voltage Electro-Impulse Deicer (LVEID) in conjunction with a composite wing. The goal of this project was to investigate and develop techniques for controlling emissions without the benefit of shielding. In this study it was determined that both EIDI and EDS could be brought within the RTCA/DO-160B standards through proper shielding and termination of the pulse power cable. An alternative topology of EDS with the impulse coil on the wing exterior surface did not meet the standard. Author

N92-19775*# Ametek, Inc., Wilmington, MA.
HIGH ACCURACY FUEL FLOWMETER. PHASE 2C AND 3: THE MASS FLOWRATE CALIBRATION OF HIGH ACCURACY FUEL FLOWMETERS Final Report
D. WILLIAM CRAFT Feb. 1992 87 p
(Contract NAS3-24357)
(NASA-CR-187108; NAS 1.26:187108) Avail: NTIS HC/MF A05 CSCL 14/2

A facility for the precise calibration of mass fuel flowmeters and turbine flowmeters located at AMETEK Aerospace Products Inc., Wilmington, Massachusetts is described. This facility is referred to as the Test and Calibration System (TACS). It is believed to be the most accurate test facility available for the calibration of jet engine fuel density measurement. The product of the volumetric flow rate measurement and the density measurement, results in a true mass flow rate determination. A dual-turbine flowmeter was designed during this program. The dual-turbine flowmeter was calibrated on the TACS to show the characteristics of this type of flowmeter. An angular momentum flowmeter was also calibrated on the TACS to demonstrate the accuracy of a true mass flowmeter having a 'state-of-the-art' design accuracy. Author

N92-19844*# Analytical Services and Materials, Inc., Hampton, VA.
SECONDARY INSTABILITY OF HIGH-SPEED FLOWS AND THE INFLUENCE OF WALL COOLING AND SUCTION
NABIL M. EL-HADY Washington NASA. Langley Research Center Feb. 1992 58 p
(Contract NAS1-18599)
(NASA-CR-4427; NAS 1.26:4427) Avail: NTIS HC/MF A04 CSCL 20/4

The periodic streamwise modulation of the supersonic and hypersonic boundary layers by a two dimensional first mode or second mode wave makes the resulting base flow susceptible to a broadband spanwise-periodic three dimensional type of instability. The principal parametric resonance of this instability (subharmonic) was analyzed using Floquet theory. The effect of Mach number and the effectiveness of wall cooling or wall suction in controlling the onset, the growth rate, and the vortical nature of the subharmonic secondary instability are assessed for both a first mode and a second mode primary wave. Results indicate that the secondary subharmonic instability of the insulated wall boundary layer is weakened as Mach number increases. Cooling of the wall destabilizes the secondary subharmonic of a second mode primary wave, but stabilizes it when the primary wave is a first mode. Suction stabilizes the secondary subharmonic at all Mach numbers. Author

N92-19873# SQM Technology, Inc., La Jolla, CA.
DEVELOPMENT OF AN ELECTROMAGNETIC MICROSCOPE FOR EDDY CURRENT EVALUATION OF MATERIALS Annual Technical Report
WALTER N. PODNEY Aug. 1991 24 p
(Contract F49620-90-C-0058)
(AD-A242007; SQMT-91-101R; AFOSR-91-0785TR) Avail: NTIS HC/MF A03 CSCL 09/5

Superconducting quantum interference devices (SQUIDs) offer new technology for locating material flaws electromagnetically. These devices offer increased sensitivity and enhanced image resolution. The sensitivity of SQUIDs to magnetic flux allows use of microscopic pickup loops in a gradiometer configuration to give high resolution. In an effort to develop SQUID technology for use in the evaluation of airframes, an electromagnetic microscope is being developed in accordance with Air Force requirements. The microscope uses an array of microscopic pickup loops for imaging micro-flaws in aluminum. The prototype is comprised of a triangular array of microscopic gradiometers that are coupled to SQUID sensors through a flexible, cryogenic umbilical, which enables convenient scanning. At this time, the development has achieved three main accomplishments: (1) a planar, azimuthal gradiometer configuration that enables suppression of source interference; (2) the instrument noise at drive currents of approximately 1 A and frequencies below a few kilohertz is on the order of SQUID noise; and (3) a cryogenic umbilical that can provide adequate cooling over a four to six foot length. GRA

N92-19976# Office National d'Etudes et de Recherches Aerospatiales, Paris (France). Direction de l'Aerodynamique.
RESOLUTION OF THE EULER EQUATIONS APPLIED TO A HELICOPTER ROTOR IN FORWARD FLIGHT Final Summary Report [RESOLUTION DES EQUATIONS D'EULER APPLIQUEE A UN ROTOR D'HELICOPTERE EN VOL D'AVANCEMENT. RAPPORT DE SYNTHESE FINAL]
J. SIDES and J. C. BONIFACE Aug. 1991 58 p In FRENCH
(Contract DRET-89-34-001)
(ONERA-RSF-2/3731-AY-004A; ETN-92-91081) Avail: NTIS HC/MF A04

The simulation of three-dimensional compressible flow around a helicopter rotor in steady flight was studied by solving the Euler equations. The centered implicit method without viscosity is extended for the wing problem and then for the isolated blade and multiblade rotor problem in stationary flight. For the wing problem, an effective development strategy of the implicit phase of the method is studied and implemented. Importance is attached to the construction of a mesh adpated to each application envisaged in the single domain computation method. First results for rotor models are presented and analyzed. ESA

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GEOSCIENCES

Includes geosciences (general); earth resources; energy production and conversion; environment pollution; geophysics; meteorology and climatology; and oceanography.

A92-25330
AUTOMATED THEMATIC PROCESSING OF AIRCRAFT SCANNER DATA GATHERED OVER PASTURE TERRITORY IN TURKMENIA [AVTOMATIZIROVANNAIA TEMATICHESKAIA OBRABOTKA DANNYKH SAMOLETNOGO SKANERA PO TERRITORII PASTBISHCH TURKMENII]
A. A. FEOKTISTOV, V. S. ARTEMKOV, V. A. ZELENIN, V. A. BOCHAROV, and E. IA. VOLCHENKO (Vsesoiuznyi Nauchno-Issledovatel'skii Tsentr AIUS-Agroresursy, Moscow, USSR) Issledovanie Zemli iz Kosmosa (ISSN 0205-9614), Sept.-Oct. 1991, p. 25-30. In Russian. refs
Copyright

A92-25501
REVIEW ON THE ABATEMENT OF HELICOPTER NOISE
TATSUYA MASUE Japan Society for Aeronautical and Space Sciences, Journal (ISSN 0021-4663), vol. 39, no. 455, 1991, p. 629-639. In Japanese. refs

Helicopter noise standards for landing, takeoff, and flight are discussed. Designs for reducing helicopter noise are presented, and the requirements for a quiet helicopter are addressed. Noise tests and results are analyzed. Y.P.Q.

A92-25747*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

ATMOSPHERIC DISTURBANCE MODEL FOR AIRCRAFT AND SPACE CAPABLE VEHICLES

BEAU C. CHIMENE, YOUNG W. PARK, W. P. BIELSKI (McDonnell Douglas Space Systems Co., Houston, TX), JOHN D. SHAUGHNESSY, and JOHN D. MCMINN (NASA, Langley Research Center, Hampton, VA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 11 p. refs
(AIAA PAPER 92-0294) Copyright

An atmospheric disturbance model (ADM) is developed that considers the requirements of advanced aerospace vehicles and balances algorithmic assumptions with computational constraints. The requirements for an ADM include a realistic power spectrum, inhomogeneity, and the cross-correlation of atmospheric effects. The baseline models examined include the Global Reference Atmospheric Model Perturbation-Modeling Technique, the Dryden Small-Scale Turbulence Description, and the Patchiness Model. The Program to Enhance Random Turbulence (PERT) is developed based on the previous models but includes a revised formulation of large-scale atmospheric disturbance, an inhomogeneous Dryden filter, turbulence statistics, and the cross-correlation between Dryden Turbulence Filters and small-scale thermodynamics. Verification with the Monte Carlo approach demonstrates that the PERT software provides effective simulations of inhomogeneous atmospheric parameters. C.C.S.

A92-26984# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

THE FORMATION AND STRUCTURE OF PLASMA WAKES BEHIND LARGE HIGH-VOLTAGE SPACE PLATFORMS IN IONOSPHERE

J. WANG (JPL, Pasadena, CA) and DANIEL E. HASTINGS (MIT, Cambridge, MA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 18 p. refs
(Contract NAG3-695)
(AIAA PAPER 92-0577) Copyright

Theory and particle simulation results are presented for ionospheric plasma flow over space platforms in the large-dimension and high-voltage range. Both the transient formation of the space-charge wake and its steady state structure are studied. The wake-side ion impact and current collection are obtained. It is found that the wake behind a high-voltage plate is characterized by two ion-rich sheaths embedded in a quasi-neutral background wake. The embedded sheath is formed by the ions passing through the sheath around the plate edge and serves as their trajectory path. Depending on the surface potential, the plate dimension, and the angle of attack, the embedded sheath may either extend downstream or curve back to the plate causing a high, localized ion flux density at the location it strikes. Author

A92-27939

SEVERE TURBULENCE WITH A LOW-LEVEL JET AHEAD OF A SQUALL LINE

EDWARD A. BRANDES (NOAA, National Severe Storms Laboratory, Norman, OK) IN: Conference on Severe Local Storms, 16th and Conference on Atmospheric Electricity, Kananaskis Park, Canada, Oct. 22-26, 1990, Preprints. Boston, MA, American Meteorological Society, 1990, p. 141-145. refs
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An account is given of an airliner's encounter with severe turbulence ahead of a squall line, which occurred on an April 26, 1984 approach to Will Rogers International Airport near Oklahoma City. The likelihood of turbulence is enhanced by the acceleration of inflow air into the thunderstorm updrafts, as well as by a reduction in static stability due to evaporative cooling below the storm's forward anvil. It is suggested that efforts to ground aircraft prior to the arrival of squall lines may actually increase the risk of a severe likelihood encounter, unless efficient detection techniques are developed. O.C.

A92-27953

UNDERSTANDING AND PREDICTING MICROBURSTS

MARILYN M. WOLFSON (MIT, Lexington, MA) IN: Conference on Severe Local Storms, 16th and Conference on Atmospheric Electricity, Kananaskis Park, Canada, Oct. 22-26, 1990, Preprints. Boston, MA, American Meteorological Society, 1990, p. 340-351. Research sponsored by FAA. refs
Copyright

The two primary forms of low altitude downdraft phenomena in thunderstorms are discussed. The differentiation between the main, precipitation-driven downdraft and the dynamically-driven downdraft associated with 'vortices' at the leading-edge of expanding thunderstorm outflows is essential to the discovery of the atmospheric conditions that lead to the development of the most hazardous microbursts. A physically based predictive model for thunderstorm downdraft strength is presented which shows the impossibility of using a storm's radar reflectivity as the sole hazard index. The static stability of the atmosphere must be taken into account. Downdrafts associated with the gust front around a cold outflow from a small isolated thunderstorm are inherently stronger at low latitudes than those in more straight-line gust fronts. O.C.

A92-27958* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

THREE-DIMENSIONAL SIMULATION OF THE DENVER 11 JULY STORM OF 1988 - AN INTENSE MICROBURST EVENT

FRED H. PROCTOR (MESO, Inc., Hampton, VA) and ROLAND L. BOWLES (NASA, Langley Research Center, Hampton, VA) IN: Conference on Severe Local Storms, 16th and Conference on Atmospheric Electricity, Kananaskis Park, Canada, Oct. 22-26, 1990, Preprints. Boston, MA, American Meteorological Society, 1990, p. 356-361. refs
(Contract NAS1-18858)
Copyright

An account is given of results from a numerical simulation of an intense microburst-generating storm observed near Denver during a test operation of the Terminal Doppler Radar System, on July 11, 1988. The numerical simulation encompassed comparisons with 'observed' data from measurements by Doppler radar, aircraft flight data recorders, and surface field instruments. Model results are in excellent qualitative and quantitative agreement with major storm feature observations. The intense microburst that was generated some distance 'downshear' of the primary precipitation area was driven by cooling due to sublimating snow. O.C.

A92-27960

PREDICTING SUMMER MICROBURST HAZARD FROM THUNDERSTORM DAY STATISTICS

JOSEPH A. CULLEN and MARILYN M. WOLFSON (MIT, Lexington, MA) IN: Conference on Severe Local Storms, 16th and Conference on Atmospheric Electricity, Kananaskis Park, Canada, Oct. 22-26, 1990, Preprints. Boston, MA, American Meteorological Society, 1990, p. 383-387. Research sponsored by FAA. refs
Copyright

A major contributor to the determination of benefits derivable from advanced wind shear detection equipment is a knowledge of the average relative microburst threat at each major airport. Thunderstorm day statistics are presently used in conjunction with measurements by the FAA's Terminal Doppler Weather Radar testbed systems to predict microburst threats. The equations thus derived for relating microbursts to thunderstorm days are noted to be suitable only for summer. O.C.

A92-27961

A CASE STUDY OF THE CLAYCOMO, MISSOURI MICROBURST ON JULY 30, 1989

PAUL J. BIRON, MARK A. ISAMINGER, KEVIN J. FLEMMING (MIT, Lexington, MA), and ALAN A. BORHO (North Dakota, University, Grand Forks) IN: Conference on Severe Local Storms, 16th and Conference on Atmospheric Electricity, Kananaskis Park, Canada, Oct. 22-26, 1990, Preprints. Boston, MA, American Meteorological Society, 1990, p. 388-392. Research sponsored by FAA. refs
Copyright

The strong multicell thunderstorm of July 30, 1989 near Claycomo generated a microburst with a maximum differential velocity of 45 m/sec. This microburst was preceded by mid- and upper-level velocity features as well as a descending, high reflectivity core. Each surface velocity differential pulse was preceded by a descent in center-of-mass altitude; this microburst would have been a considerable hazard to an aircraft penetrating the outflow. O.C.

A92-27962
A PROTOTYPE MICROBURST PREDICTION PRODUCT FOR THE TERMINAL DOPPLER WEATHER RADAR
STEVEN D. CAMPBELL and MARK A. ISAMINGER (MIT, Lexington, MA) IN: Conference on Severe Local Storms, 16th and Conference on Atmospheric Electricity, Kananaskis Park, Canada, Oct. 22-26, 1990, Preprints. Boston, MA, American Meteorological Society, 1990, p. 393-396. Research sponsored by FAA. refs
Copyright

The present Terminal Doppler Weather Radar (TDWR) microburst-recognition algorithm makes use of such features as reflectivity cores and convergence to recognize microburst precursors. The algorithm uses precursors to make a microburst declaration while the surface outflow remains weak, thereby improving hazard-warning time. The prototype prediction product is tuned to predict the high-reflectivity microbursts typical of humid regions of the U.S., which are expected to be most representative of TDWR installation sites. O.C.

A92-27963
ASPECT ANGLE DEPENDENCE OF OUTFLOW STRENGTH IN DENVER MICROBURSTS - SPATIAL AND TEMPORAL VARIATIONS
ROBERT G. HALLOWELL (MIT, Lexington, MA) IN: Conference on Severe Local Storms, 16th and Conference on Atmospheric Electricity, Kananaskis Park, Canada, Oct. 22-26, 1990, Preprints. Boston, MA, American Meteorological Society, 1990, p. 397-402. Research sponsored by FAA. refs
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Results from a detailed study of 96 individual observations from 27 microburst events to develop and test the Terminal Doppler Weather Radar (TDWR) wind shear surveillance system are presented. As part of this study MIT Lincoln Laboratory has developed algorithms for automatically detecting microbursts, or thunderstorm outflows utilizing the radial velocity data gathered from a single TDWR. The data show that microbursts, on average, have maximum strengths and extents that are 1.9:1 and 1.5:1 asymmetric, respectively. R.E.P.

A92-27991* National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, FL.
EXPERT KNOWLEDGE TECHNIQUES APPLIED TO THE ANALYSIS OF ELECTRIC FIELD MILL DATA
JAMES R. NICHOLSON (NASA, Kennedy Space Center, Cocoa Beach, FL) and ALICE M. MULVEHILL (Mitre Corp., Bedford, MA) IN: Conference on Severe Local Storms, 16th and Conference on Atmospheric Electricity, Kananaskis Park, Canada, Oct. 22-26, 1990, Preprints. Boston, MA, American Meteorological Society, 1990, p. J36-J39. refs
(Contract NAS10-11572)
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NASA operates a network of ground-based electric field mills at Kennedy Space Center (KSC) to identify clouds which might be an electrical hazard to space vehicle prior to and during launch or to the various ground operations performed at the center. Artificial intelligence has been used to develop an expert system for analyzing electric field mill data. The application of the system to expert system to small thunderstorms at KSC is shown. C.D.

N92-19121*# National Aeronautics and Space Administration, Washington, DC.
THE ATMOSPHERIC EFFECTS OF STRATOSPHERIC AIRCRAFT: A FIRST PROGRAM REPORT
MICHAEL J. PRATHER, HOWARD L. WESOKY, RICHARD C. MIAKE-LYE, ANNE R. DOUGLASS, RICHARD P. TURCO, DONALD J. WUEBBLES, MALCOLM K. W. KO, and ARTHUR L. SCHMELTEKOPF (National Oceanic and Atmospheric Administration, Washington, DC.) Jan. 1992 227 p
(NASA-RP-1272; NAS 1.61:1272) Avail: NTIS HC/MF A11
CSCL 13/2

Studies have indicated that, with sufficient technology development, high speed civil transport aircraft could be economically competitive with long haul subsonic aircraft. However, uncertainty about atmospheric pollution, along with community noise and sonic boom, continues to be a major concern; and this is addressed in the planned 6 yr HSRP begun in 1990. Building on NASA's research in atmospheric science and emissions reduction, the AESA studies particularly emphasizing stratospheric ozone effects. Because it will not be possible to directly measure the impact of an HSCT aircraft fleet on the atmosphere, the only means of assessment will be prediction. The process of establishing credibility for the predicted effects will likely be complex and involve continued model development and testing against climatological patterns. Lab simulation of heterogeneous chemistry and other effects will continue to be used to improve the current models.

N92-19122*# Aerodyne Research, Inc., Billerica, MA.
HIGH-SPEED CIVIL TRANSPORT AIRCRAFT EMISSIONS
RICHARD C. MIAKE-LYE, J. A. MATULAITIS, F. H. KRAUSE, WILLARD J. DODDS, MARTIN ALBERS, J. HOURMOUZIADIS, K. L. HASEL, R. P. LOHMANN, C. STANDER, JOHN H. GERSTLE (Boeing Commercial Airplane Co., Seattle, WA.) et al. *In* NASA, Washington, The Atmospheric Effects of Stratospheric Aircraft: A First Program Report p 13-31 Jan. 1992 Prepared in cooperation with Douglas Aircraft Co., Inc., Long Beach, CA
Avail: NTIS HC/MF A11 CSCL 13/2

Estimates are given for the emissions from a proposed high speed civil transport (HSCT). This advanced technology supersonic aircraft would fly in the lower stratosphere at a speed of roughly Mach 1.6 to 3.2 (470 to 950 m/sec or 920 to 1850 knots). Because it would fly in the stratosphere at an altitude in the range of 15 to 23 km commensurate with its design speed, its exhaust effluents could perturb the chemical balance in the upper atmosphere. The first step in determining the nature and magnitude of any chemical changes in the atmosphere resulting from these proposed aircraft is to identify and quantify the chemically important species they emit. Relevant earlier work is summarized, dating back to the Climatic Impact Assessment Program of the early 1970s and current propulsion research efforts. Estimates are provided of the chemical composition of an HSCT's exhaust, and these emission indices are presented. Other aircraft emissions that are not due to combustion processes are also summarized; these emissions are found to be much smaller than the exhaust emissions. Future advances in propulsion technology, in experimental measurement techniques, and in understanding upper atmospheric chemistry may affect these estimates of the amounts of trace exhaust species or their relative importance. Author

N92-19123*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
NATURAL CYCLES, GASES
ANNE R. DOUGLASS, CHARLES H. JACKMAN, R. B. ROOD, A. C. AIKIN, R. S. STOLARSKI, M. P. MCCORMICK, and DAVID W. FAHEY (National Oceanic and Atmospheric Administration, Boulder, CO.) *In* NASA, Washington, The Atmospheric Effects of Stratospheric Aircraft: A First Program Report p 33-61 Jan. 1992
Avail: NTIS HC/MF A11 CSCL 13/2

The major gaseous components of the exhaust of stratospheric aircraft are expected to be the products of combustion (CO2 and H2O), odd nitrogen (NO, NO2 HNO3), and products indicating combustion inefficiencies (CO and total unburned hydrocarbons). The species distributions are produced by a balance of photochemical and transport processes. A necessary element in evaluating the impact of aircraft exhaust on the lower stratospheric composition is to place the aircraft emissions in perspective within

the natural cycles of stratospheric species. Following are a description of mass transport in the lower stratosphere and a discussion of the natural behavior of the major gaseous components of the stratospheric aircraft exhaust. Author

N92-19125*# National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York, NY.
DESIGNING A METHODOLOGY FOR FUTURE AIR TRAVEL SCENARIOS
DONALD J. WUEBBLES, STEVEN L. BAUGHCUM, JOHN H. GERSTLE, JAE EDMONDS, DOUGLAS E. KINNISON, NICK KRULL, MUNIR METWALLY, ALAN MORTLOCK (McDonnell-Douglas Corp., Long Beach, CA.), and MICHAEL J. PRATHER *In* NASA, Washington, The Atmospheric Effects of Stratospheric Aircraft: A First Program Report p 93-113 Jan. 1992
Avail: NTIS HC/MF A11 CSCL 13/2

The growing demand on air travel throughout the world has prompted several proposals for the development of commercial aircraft capable of transporting a large number of passengers at supersonic speeds. Emissions from a projected fleet of such aircraft, referred to as high-speed civil transports (HSCT's), are being studied because of their possible effects on the chemistry and physics of the global atmosphere, in particular, on stratospheric ozone. At the same time, there is growing concern about the effects on ozone from the emissions of current (primarily subsonic) aircraft emissions. Evaluating the potential atmospheric impact of aircraft emissions from HSCT's requires a scientifically sound understanding of where the aircraft fly and under what conditions the aircraft effluents are injected into the atmosphere. A preliminary set of emissions scenarios are presented. These scenarios will be used to understand the sensitivity of environment effects to a range of fleet operations, flight conditions, and aircraft specifications. The baseline specifications for the scenarios are provided: the criteria to be used for developing the scenarios are defined, the required data base for initiating the development of the scenarios is established, and the state of the art for those scenarios that have already been developed is discussed. An important aspect of the assessment will be the evaluation of realistic projections of emissions as a function of both geographical distribution and altitude from an economically viable commercial HSCT fleet. With an assumed introduction date of around the year 2005, it is anticipated that there will be no HSCT aircraft in the global fleet at that time. However, projections show that, by 2015, the HSCT fleet could reach significant size. We assume these projections of HSCT and subsonic fleets for about 2015 can the be used as input to global atmospheric chemistry models to evaluate the impact of the HSCT fleets, relative to an all-subsonic future fleet. The methodology, procedures, and recommendations for the development of future HSCT and the subsonic fleet scenarios used for this evaluation are discussed. Author

N92-19126*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
OZONE RESPONSE TO AIRCRAFT EMISSIONS: SENSITIVITY STUDIES WITH TWO-DIMENSIONAL MODELS
MALCOLM K. W. KO, DEBRA WEISENSTEIN, CHARLES H. JACKMAN, ANNE R. DOUGLASS, K. BURESKE, DONALD J. WEUBBLES, DOUGLAS E. KINNISON, G. BRASSEUR, J. PYLE, and ANNA JONES (Cambridge Univ., England) *In* NASA, Washington, The Atmospheric Effects of Stratospheric Aircraft: A First Program Report p 115-157 Jan. 1992 Prepared in cooperation with NASA. Langley Research Center; Edinburgh Univ.; and Oslo Univ.
Avail: NTIS HC/MF A11 CSCL 13/2

Our first intercomparison/assessment of the effects of a proposed high-speed civil transport (HSCT) fleet on the stratosphere is presented. These model calculations should be considered more as sensitivity studies, primarily designed to serve the following purposes: (1) to allow for intercomparison of model predictions; (2) to focus on the range of fleet operations and engine specifications giving minimal environmental impact; and (3) to provide the basis for future assessment studies. The basic scenarios were chosen to be as realistic as possible, using the information available on anticipated developments in technology. They are not to be interpreted as a commitment or goal for environmental acceptability. Author

N92-19127*# National Oceanic and Atmospheric Administration, Boulder, CO.
LOWER STRATOSPHERIC MEASUREMENT ISSUES WORKSHOP REPORT
ARTHUR L. SCHMELTEKOPF *In* NASA, Washington, The Atmospheric Effects of Stratospheric Aircraft: A First Program Report p 159-186 Jan. 1992
Avail: NTIS HC/MF A11 CSCL 13/2

The Lower Stratospheric Measurement Issues workshop was held on 17-19 Oct. 1990. The 3-day workshop was sponsored by the Atmospheric Effects of Stratospheric Aircraft (AESA) component of the High Speed Research Program (HSRP). Its purpose was to provide a scientific forum for addressing specific issues regarding chemistry and transport in the lower stratosphere, for which measurements are essential to an assessment of the environmental impact of a projected fleet of high speed civil transports (HSCTs). The objective of the workshop was to obtain vigorous and critical review of the following topics: (1) atmospheric measurements needed for the assessment; (2) present capability for making those measurements; and (3) areas in instrumentation or platform development essential to making the measurements. Author

N92-19195# Colorado State Univ., Fort Collins.
OPERATING RANGES OF METEOROLOGICAL WIND TUNNELS FOR THE SIMULATION OF CONVECTIVE BOUNDARY LAYER PHENOMENA
ROBERT N. MERONEY and WILLIAM H. MELBOURNE 10 Dec. 1991 37 p
(Contract N00014-88-K-0029)
(AD-A244153; CEP90-91-RNM-WNM-11) Avail: NTIS HC/MF A03 CSCL 04/2

The operating ranges of meteorological wind tunnels for convective boundary layer (CBL) simulation are defined in this paper on a review of the theoretical and practical limitations of the flow phenomena and the facilities available. Wind tunnel operating ranges are limited by the dimensions of the simulated circulations and of the tunnel itself, the tunnel flow speed and turbulence processes, and the characteristics of the measurement instrumentation. When it is desired to simulate both the convective boundary layer and the behavior of other flows imbedded within the boundary layer, such as power plant plume rise and dispersion, then additional constraints exist on the fluid modeling process. The capabilities of meteorological wind tunnels can also be extended through the judicious use of boundary and side wall flow controls. GRA

N92-19231# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
THE APPLICATION OF STATISTICAL ESTIMATION TECHNIQUES TO TERRAIN MODELING M.S. Thesis
DONALD P. DUCKETT, JR. Dec. 1991 242 p
(AD-A243799; AFIT/GCE/ENG/91D-02) Avail: NTIS HC/MF A11 CSCL 08/2

This thesis researches methods of generating accurate and realistic polygonal terrain models by reducing gridded sampled terrain elevation data such as DMA DTED. The terrain models generated should be applicable for use in flight simulators and other systems. Existing methods of terrain modeling are discussed, and limitations of these systems are presented. The geostatistical estimation technique known as kriging is presented as a method estimating terrain elevations at locations not provided in DMA DTED or other gridded terrain elevation data. Kriging is an optimal interpolation method based on statistical analysis of the data. It also provides a measure of accuracy, the error variance, that allows some control over the accuracy of the resulting terrain model. This estimation method is employed in a terrain modeling system that builds polygonal terrain models at any resolution. This

system is described in this thesis, and the results of terrain modeled both by filtering the DMA DTED and by estimating elevations with kriging are presented. The technique as implemented is computationally very expensive and has therefore limited the results of this thesis effort. Also, terrain models that could be produced appeared smoother than their filtered counterparts. However, kriging still shows promise as a method of estimating terrain elevations for terrain models. GRA

N92-19292# Deutsche Forschungsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (Germany, F.R.). Inst. fuer Physik der Atmosphaere.
SIMPLE MODELS FOR THE DESCRIPTION OF TURBULENCE IN THE ATMOSPHERIC BOUNDARY LAYER
ANNE M. JOCHUM Nov. 1990 82 p In GERMAN; ENGLISH summary
(DLR-FB-90-17; ISSN-0939-2963; ETN-92-90731) Avail: NTIS HC/MF A05; DLR, Wissenschaftliches Berichtswesen, VB-PL-DO, Postfach 90 60 58, 5000 Cologne, Fed. Republic of Germany, HC 27 DM

Simple methods for classifying atmospheric boundary layer states and describing atmospheric boundary layer turbulence over homogeneous land surfaces are reviewed. A new method is proposed to evaluate turbulence parameters from routine meteorological observations. This method is based on a combination of similarity theory and available parameterization schemes for surface fluxes and atmospheric boundary layer depth. It consists of a basic module of a simple method to predict and evaluate aircraft reaction in turbulent air on a routine basis. ESA

N92-19633# Midwest Research Inst., Golden, CO.
THE NREL TEETERING HUB ROTOR CODE: FINAL RESULTS AND CONCLUSIONS
A. D. WRIGHT and C. P. BUTTERFIELD Dec. 1991 10 p Presented at the American Society of Mechanical Engineers (ASME) Energy Sources Technology Conference and Exhibition, Houston, TX, 26-30 Jan. 1992
(Contract DE-AC02-83CH-10093)
(DE92-001187; NREL/TP-257-4517; CONF-920122-4) Avail: NTIS HC/MF A02

Accurately predicting wind turbine blade loads and response is important for the proper design of wind turbines. The need to accurately predict both deterministic and stochastic blade loads is now widely recognized. Previous rotor code development and validation efforts at NREL have concentrated on prediction of deterministic and stochastic blade loads for rigid hub rotors. During the past year, this effort was expanded for predicting blade and shaft loads for two-bladed teetering hub rotors. The NREL (formerly SERI) Teetering Rotor Analysis Program (STRAP), a derivative of the Force and Loads Analysis Program (FLAP), can include the effects of rotor undersling, delta-3, and the effects of a concentrated hub mass. The degrees of freedom include rotor teeter and symmetric and asymmetric rotor flap modes. A time-dependent, prescribed yaw motion can also be input to the code. Loads due to turbulent wind inputs are also calculated. In this paper, final code modifications, final comparisons of load predictions to test data, and finally, the direction for new code development activities at NREL are described. DOE

N92-19667# Meteorological Satellite Center, Tokyo (Japan).
ON THE RELATION BETWEEN CUMULUS CLOUD LINES AND SURFACE SHEAR LINES
FUMIO UEDA *In its* Meteorological Satellite Center Technical Note, no. 22, 1991 p 31-39 Mar. 1991 In JAPANESE; ENGLISH summary
Avail: NTIS HC/MF A04

The relationship between cumulus cloud lines and surface shear lines were studied. A surface shear line is connected to a Low Altitude Wind Shear (LAWS). LAWS is a phenomenon that affects the aircraft just on landing or takeoff. From an aviational point of view, the relationship between LAWS and cumulus cloud lines was to be studied, but because of insufficiency of the observation report of LAWS, the relation between shear lines and cumulus cloud lines was studied. The findings were as follows: (1) cloud lines can be classified into moving and stationary and into off the east and off the south coasts; (2) stationary cloud line east of Choshi does not correspond to surface shear line; (3) stationary cloud line off the south coast does not correspond to surface shear line that continues to inner land; (4) moving cloud line off the east coast corresponds to surface shear line - this cloud line is formed as a part of a comma-shaped cloud; and (5) cloud line moving off the south coast eastward with the cold front band does not correspond to surface shear line directly. Author

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MATHEMATICAL AND COMPUTER SCIENCES

Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

A92-24411
EXPERT SYSTEM FOR REAL-TIME AIRCRAFT MONITORING
JOEY B. FLANDERS, ROBIN M. MADISON (USAF, Flight Test Center, Edwards AFB, CA), and CHARLES H. JONES (Washington State University, Pullman) Journal of Aircraft (ISSN 0021-8669), vol. 29, Jan.-Feb. 1992, p. 79-84. Previously cited in issue 14, p. 2234, Accession no. A90-33921. refs

A92-24423
USING FRACTAL DIMENSION FOR TARGET DETECTION IN CLUTTER
KIM T. CONSTANTIKES (Johns Hopkins University, Laurel, MD) Johns Hopkins APL Technical Digest (ISSN 0270-5214), vol. 12, Oct.-Dec. 1991, p. 301-309. refs
Copyright

The fractal character of natural surfaces which present themselves to radar as clutter is the starting-point for the present method of distinguishing highly regular and smooth-contoured ships and aircraft via fractal dimension estimates. A numerical experiment involving the search for a T-38 aircraft against variously cluttered backgrounds is conducted. The 'Hurst estimator' is found to yield good results on one-dimensional fratal approximations. Attention is given to a technique for finding scaling regions for the estimate; when the estimator was extended to the 2D case, it became possible to segment the aircraft from a cluttered image. O.C.

A92-24905
ON AN ADAPTIVE NUMERICAL METHOD FOR SOLUTION OF HIGH GRADIENT PROBLEMS
A. N. KUDRIAVTSEV and A. S. SOLOV'EV (Academy of Sciences of the USSR, Institute of Theoretical and Applied Mechanics, Novosibirsk) Russian Journal of Theoretical and Applied Mechanics (ISSN 1051-8045), vol. 1, Sept. 1991, p. 265-272. refs
Copyright

A new numerical method for the solution of initial boundary-value problems is proposed. Spatial derivatives are approximated by finite-difference formulas on nonuniform grids. Grid nodes in the course of computing concentrate in high-gradient regions. The explicit time-integration scheme is constructed so that stability restrictions on the time step are sufficiently weaker. By means of test computations for the one-dimensional Burgers' equation, the efficiency of the method is demonstrated. Author

A92-25108
A NEW METHOD FOR SOLVING THE KERNEL EQUATIONS OF TRANSONIC FLOWS - AN AUXILIARY KERNEL METHOD
JICHAO SU (Beijing University of Aeronautics and Astronautics, People's Republic of China) Acta Aerodynamica Sinica (ISSN 0258-1825), vol. 9, Sept. 1991, p. 351-355. In Chinese. refs

A new auxiliary kernel method for solving kernel equations is proposed which eliminates the limitation of the doublet lattice method on the distribution of mesh grids. Numerical calculations show that this method is more efficient than the double lattice method for transonic flows with shocks around airfoils. C.D.

A92-26368

FROM CONCEPT TO MODEL: CONCEPTION AND EVALUATION OF AN ARCHITECTURE FOR A DISTRIBUTED SYSTEM WITH SAHARA - SOME REFLECTIONS ON RESULTS OF THE UTILIZATION OF SAHARA IN THE FRAMEWORK OF THE ELECTRONIC COPILOT [DU CONCEPT A LA MAQUETTE: CONCEVOIR ET EVALUER UNE ARCHITECTURE DE SYSTEME DISTRIBUE AVEC SAHARA - QUELQUES REFLEXIONS SUR LES RESULTATS DE L'UTILISATION DE SAHARA DANS LE CADRE DU COPILOTE ELECTRONIQUE]

MICHEL BARAT, PHILIPPE BENHAMOU (ONERA, Direction des Moyens d'Informatique, Chatillon, France), JACQUES FERBER (Paris VI, Universite, France), and PASCAL NORY (Dassault Aviation, Saint-Cloud, France) (Le Genie Logiciel et ses Applications, Meeting, Toulouse, France, Dec. 9-13, 1991) ONERA, TP no. 1991-216, 1991, 15 p. In French. refs
(Contract DRET-89-001-31; DRET-89-34347)
(ONERA, TP NO. 1991-216)

The SAHARA software engineering tool is described, and its application to the Electronic Copilot program of Dassault Aviation is discussed. The system under study is modeled using the LADA architecture description language, and the aspects of temporality and interruptibility characterizing the projected systems are considered in detail. Some reflections on results obtained with simulations of the Electronic Copilot are presented. L.M.

A92-26968# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

THE NASA COMPUTATIONAL AEROSCIENCES PROGRAM - TOWARD TERAFLOPS COMPUTING

TERRY L. HOLST (NASA, Ames Research Center, Moffett Field, CA), MANUEL D. SALAS (NASA, Langley Research Center, Hampton, VA), and RUSSELL W. CLAUS (NASA, Lewis Research Center, Cleveland, OH) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 25 p. refs
(AIAA PAPER 92-0558) Copyright

The Computational Aerosciences (CAS) project of the High Performance Computing and Communications program is presented and discussed. The main emphasis of this presentation is on the applications portion of the CAS program, which includes a High-Speed Civil Transport element, a High Performance Aircraft element, a NASP-Derived Vehicle element, and an Aerobraking element. Two major thrusts of this program are the enhancement of simulation capabilities using multidiscipline formulations and the improvement in processing efficiency via massive parallel computer hardware. Current activities in these two areas at Ames, Langley and Lewis, are presented and discussed. Author

A92-26970#

SOLUTION OF THE EULER AND NAVIER-STOKES EQUATIONS ON MIMD DISTRIBUTED MEMORY MULTIPROCESSORS USING CYCLIC REDUCTION

ENRIQUE N. CURCHITSER, RICHARD B. PELZ (Rutgers University, Piscataway, NJ), and FRANK MARCONI (Grumman Aerospace Corp., Bethpage, NY) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 15 p. Research supported by Grumman Aerospace Corp. refs
(AIAA PAPER 92-0561) Copyright

The Euler and Navier-Stokes equations are solved for the steady, two-dimensional flow overa a NACA 0012 airfoil using a 1024 node nCUBE/2 multiprocessor. Second-order, upwind-discretized difference equations are solved implicitly using ADI factorization. Parallel cyclic reduction is employed to solve the block tridiagonal systems. For realistic problems, communication times are negligible compared to calculation times. The processors are tightly synchronized, and their loads are well balanced. When the flux Jacobians flux are frozen, the wall-clock time for one implicit timestep is about equal to that of a multistage explicit scheme. Author

A92-26992#

THE SOFTWARE FACTORY, VERSION 5.0

ARLEN N. LONG and SHARILYN A. THORESON (McDonnell Aircraft Co., Saint Louis, MO) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 6 p. refs
(AIAA PAPER 92-0590) Copyright

The Software Factory (SWF) is a software backplane and integrated toolset for avionics software development. Today, SWF operates on VMS platforms using an Xwindows interface. The next release, SWF 5.0, is based on a new architecture consisting of a system of distributed client-server processes. This article describes the new architecture and new user interface of The Software Factory. Author

A92-27034#

EMBEDDED MESHES OF CONTROLLABLE QUALITY SYNTHESISED FROM ELEMENTARY GEOMETRIC FEATURES

C. M. ALBONE (Defence Research Agency, Aerospace Div., Farnborough, England) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 14 p. refs
(AIAA PAPER 92-0663) Copyright

A method is described for generating surface and field meshes around complex aircraft configurations. The method, which is known by the acronym FAME (Feature-Associated Mesh Embedding), is being developed with the twin objectives of combining a high degree of automation and ease of use with precise control over mesh quality. It is of composite, overlapping type, and it employs many surface-aligned meshes together with a multiply-embedded background mesh. High-quality meshes should be achievable for configurations with closely-coupled components and for those with components in relative motion. Several examples are shown of meshes generated for configurations having geometrically simple components but combined to form shapes that are representative of practical complex aircraft configurations. Author

A92-27347* National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

DECENTRALIZED-FEEDBACK POLE PLACEMENT OF LINEAR SYSTEMS

X. WANG, C. F. MARTIN, D. GILLIAM (Texas Tech University, Lubbock), and C. I. BYRNES (Washington University, Saint Louis, MO) International Journal of Control (ISSN 0020-7179), vol. 55, Feb. 1992, p. 511-518. Research supported by Texas Advanced Research Program. refs
(Contract NAG2-89; NSF DMS-89-05334; NSF DMS-90-08223; AF-AFOSR-88-0309; MDA904-90-H-4009)
Copyright

A projectile product spaces model is used to analyze decentralized systems. The degree of the pole placement map is computed. The conditions under which the degree is odd are also given. Twin lift systems are studied. It is proved that the poles of a twin lift system can be assigned to any values by local static and local dynamic feedback laws if and only if the system is jointly controllable. Author

A92-27858

A NEW U-D FACTORIZATION-BASED FIXED-POINT SMOOTHER AND APPLICATION TO FLIGHT TEST

ZHONGKE SI (Northwestern Polytechnical University, Xian, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, Sept. 1991, p. A488-A494. In Chinese. refs

A new computationally efficient U-D factorization-based fixed-point smoother is developed using the Kalman filter and the Rauch fixed-point smoother. In the new algorithm, the estimated error covariance propagation is divided into two parts and the difference of the positive semidefinite matrices subject to numerical instability and the Kalman filter estimate for the new smoother is simplified. To get high numerical stability and computational

efficiency, U-D factorization is used for propagation of estimated error covariance for both the Kalman filter and the new smoother. A comparison of operational counts shows that the new smoother is more than 1.5 times as efficient as the Rauch, Bryson-Frazier, and Bryson-Ho fixed-point smoothers. If the dimension of state is much larger than the dimension of process noise, the new algorithm will be two to five times more efficient than the ordinary ones. A new scheme for flight state smoothing and aerodynamic coefficient identification is presented. C.D.

A92-27859
ROBUSTNESS ANALYSIS OF A MODEL REFERENCE ADAPTIVE CONTROL SYSTEM
SHUNDA XIAO, JIAN LUO, and WEI WANG (Northwestern Polytechnical University, Xian, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, Sept. 1991, p. A495-A500. In Chinese. refs

The purpose of this paper is to prove the robustness of a scheme of model-reference adaptive control system (MRACS) of pitching velocity to the unmodeled long-period mode. A special state equation is deduced from a factored transfer function of longitudinal aircraft motion. By means of transformation the effect of the long-period mode can be shown as an equivalent slowly varying disturbance acting on the approximate model of the system considering only the effect of the short-period mode. By virtue of the performance of MRACS in accommodating the slow parameter perturbation of the plant and suppressing the slowly varying disturbances the robustness of the MRACS is demonstrated. Author

A92-28136
ADAPTIVE SIMULATOR MOTION SOFTWARE WITH SUPERVISORY CONTROL
M. A. NAHON (Aercol, Ltd., Toronto, Canada), L. D. REID, and J. KIRDEIKIS (Toronto, University, Canada) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 15, Mar.-Apr. 1992, p. 376-383. Research supported by Aercol, Ltd. and NSERC. Previously cited in issue 04, p. 600, Accession no. A91-16688. refs
Copyright

A92-28142
OPTIMAL OUTPUT FEEDBACK FOR LINEAR TIME-PERIODIC SYSTEMS
ANTHONY J. CALISE, MARK E. WASIKOWSKI, and DANIEL P. SCHRAGE (Georgia Institute of Technology, Atlanta) Journal of Guidance, Control, and Dynamics (ISSN 0731-5090), vol. 15, Mar.-Apr. 1992, p. 416-423. Previously cited in issue 23, p. 3705, Accession no. A89-52657. refs
(Contract DAAL03-88-C-0003)
Copyright

A92-28494
AUTOMATED MISSION PLANNING - A STRIKING CAPABILITY
ARTHUR HANLEY Aerospace America (ISSN 0740-722X), vol. 30, March 1992, p. 34-38.
Copyright

The Tactical Aircraft Mission Planning System (TAMPS) is described in terms of its structure and computer-based support, and some potential applications are discussed. TAMPS holds Ada databases for 38 aircraft/weaponry systems on performance and maneuverability, and the mission planner selects the optimal route and modes for a given mission. TAMPS can be employed in a variety of situations to optimize mission performance and to digitally display terrain and other features. C.C.S.

N92-18125*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.
SOFTWARE ENGINEERING LABORATORY (SEL) ADA PERFORMANCE STUDY REPORT
ERIC W. BOOTH (Computer Sciences Corp., Greenbelt, MD.) and MICHAEL E. STARK Jul. 1991 69 p
(NASA-TM-105510; SEL-91-003; NAS 1.15:105510) Avail: NTIS HC/MF A04 CSCL 09/2

The goals of the Ada Performance Study are described. The methods used are explained. Guidelines for future Ada development efforts are given. The goals and scope of the study are detailed, and the background of Ada development in the Flight Dynamics Division (FDD) is presented. The organization and overall purpose of each test are discussed. The purpose, methods, and results of each test and analyses of these results are given. Guidelines for future development efforts based on the analysis of results from this study are provided. The approach used on the performance tests is discussed. Author

N92-18252# National Aeronautical Lab., Bangalore (India). Flight Mechanics and Controls Div.
GRAPHICS FOR INTERACTIVE PC BASED PARAMETER ESTIMATION PACKAGE
C. SUNILKUMAR and GIRIJA GOPALRATNAM Dec. 1991 22 p
(Contract NAL PROJ. FC-8-101)
(NAL-PD-FC-9117) Avail: NTIS HC/MF A03

The capabilities are described of a graphics package developed in Turbo-C for use in interactive flight data analysis using a maximum likelihood estimation method. Flight trajectory analysis can be performed starting from the data base arising from flight dynamic experiments, wind tunnel simulation, and aeroballistic range data. Details are provided of the graphics package developed for plotting the data. Author

N92-18647# Agusta Sistemi S.p.A., Tradate (Italy). Systems and Space Business Unit.
RAMREQ: A COMPUTERIZED TOOL FOR THE DEFINITION OF RAM (RELIABILITY, AVAILABILITY, MAINTAINABILITY) REQUIREMENTS OF COMPLEX SYSTEMS
P. CAMERINO *In* ESA, Space Product Assurance for Europe in the 1990s: An ESA Symposium p 239-247 Aug. 1991 Sponsored by ESA/ESTEC
Copyright Avail: NTIS HC/MF A13

The software package RAMREQ developed to define the RAM requirements of complex systems (helicopters, aircrafts, and space systems) by the integration of appropriate deductive (top down) and inductive (bottom up) techniques is described. The approach and the mathematical models of RAMREQ, and its preliminary software requirements, were developed under contract for ESA/ESTEC. The validation of the method is carried out in defining the RAM requirements for Hermes. The overall logic flow of the RAMREQ software tool is split into three main processes: the top down RAM apportionment process which makes use of preliminary system information; the bottom up RAM prediction process which makes use of conventional RAM prediction and modeling techniques; and the comparison, assignment, and feedback process which provides the final outputs, and controls the whole model by continuous feedback and cost optimization. These three processes are described in detail. ESA

N92-19247# BBN Systems and Technologies Corp., Cambridge, MA.
MULTIRAD Final Technical Report
Jun. 1991 32 p
(Contract MDA972-89-C-0060; MDA972-89-C-0061)
(AD-A244211; BBN-7621) Avail: NTIS HC/MF A03 CSCL 12/5

This report describes a Simulation Network (SIMNET) project final report of the Multirad network software of the SIMNET hardware and software training system for vehicle crew training and operational training. GRA

N92-19335# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.
AN ALGORITHM FOR ROBUST EIGENSTRUCTURE ASSIGNMENT USING THE LINEAR QUADRATIC REGULATOR
M.S. Thesis
THOMAS C. HUCKABONE Dec. 1991 119 p

(AD-A244267; AFIT/GAE/ENY/91D-7) Avail: NTIS HC/MF A06 CSCL 12/5

The Linear Quadratic Regulator (LQR) can guarantee a robust closed loop eigenstructure for full state feedback. The algorithm developed here takes advantage of the stability guarantees of LQR to achieve an eigenstructure close to desired but within the allowable region of LQR. The algorithm selects the LQR weighting matrices, Q and R, that minimize the distance between the elements of the desired and LQR achievable eigenstructures. The minimization is accomplished by using a simplex based optimization routine. Specific weightings placed on the elements of the desired eigenstructure define the relative importance of each element. The algorithm is programmed in FORTRAN and is designed to be run from the software package MATLAB. Two examples are examined to illustrate the use of the program, including a helicopter flight control system. The results show that this algorithm is a valid technique for achieving robust eigenstructure assignment with full state feedback. GRA

N92-19397# California Univ., Berkeley. Electronics Research Lab.

ADAPTIVE CONTROL OF NONLINEAR SYSTEMS WITH APPLICATIONS TO THE CONTROL OF FLEXIBLE ROBOT ARMS Final Report, 15 Jun. 1988 - 14 Jun. 1991

S. S. SASTRY 28 Oct. 1991 36 p

(Contract DAAL03-88-K-0106)

(AD-A244409; ARO-25844.13-MA) Avail: NTIS HC/MF A03 CSCL 12/4

On this grant we made major progress in three areas. The first was adaptive control of nonlinear systems. In this work, we extended our previous work on direct adaptive control of Single Input single output nonlinear systems to schemes for adaptive identification, indirect adaptive control and also adaptive model matching of multi input multi output nonlinear systems. We also studied adaptive versions of the nonlinear regulator. The second area was approximate linearization (by state feedback) of nonlinear systems. While the full set of conditions for input-output linearization of a nonlinear system by state feedback have been given in the literature, the question of how to proceed when the conditions follow slightly short of being met have not been answered. For example, input-output linearization hinges on a certain set of regularity conditions (existence of relative degree in the SISO case) and minimum phase conditions being met by the plant. If the plant is not regular and is slightly nonminimum phase the techniques of input-output linearization need to be modified. We discussed these techniques in the context of flight control and also other examples, for instance, the ball and beam system. This in turn led to a deeper understanding of the structure of the zero dynamics of a nonlinear system and their structure under perturbation. The third area was CAD tools for nonlinear controller design. We have developed a set of CAD tools for linearization and approximate linearization of nonlinear systems using spline software which operates in real time and is capable of accepting nonlinear system description in numeric, tabular, or functional form. A user interface is being written and is is being tried out on several examples. GRA

N92-19422*# Computer Sciences Corp., Lanham, MD.

IMPACT OF A PROCESS IMPROVEMENT PROGRAM IN A PRODUCTION SOFTWARE ENVIRONMENT: ARE WE ANY BETTER?

GERARD H. HELLER and GERALD T. PAGE *In* NASA. Goddard Space Flight Center, Proceedings of the 15th Annual Software Engineering Workshop 26 p Nov. 1990

Avail: NTIS HC/MF A99 CSCL 09/2

For the past 15 years, Computer Sciences Corporation (CSC) has participated in a process improvement program as a member of the Software Engineering Laboratory (SEL), which is sponsored by GSFC. The benefits CSC has derived from involvement in this program are analyzed. In the environment studied, it shows that improvements were indeed achieved, as evidenced by a decrease in error rates and costs over a period in which both the size and the complexity of the developed systems increased substantially. The principles and mechanics of the process improvement program, the lessons CSC has learned, and how CSC has capitalized on these lessons are also discussed. Author

N92-19423*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

TOWARDS UNDERSTANDING SOFTWARE: 15 YEARS IN THE SEL

FRANK MCGARRY and ROSE PAJERSKI *In its* Proceedings of the 15th Annual Software Engineering Workshop 32 p Nov. 1990

Avail: NTIS HC/MF A99 CSCL 09/2

For 15 years, the Software Engineering Laboratory (SEL) at GSFC has been carrying out studies and experiments for the purpose of understanding, assessing, and improving software, and software processes within a production software environment. The SEL comprises three major organizations: (1) the GSFC Flight Dynamics Division; (2) the University of Maryland Computer Science Department; and (3) the Computer Sciences Corporation Flight Dynamics Technology Group. These organizations have jointly carried out several hundred software studies, producing hundreds of reports, papers, and documents: all describing some aspect of the software engineering technology that has undergone analysis in the flight dynamics environment. The studies range from small controlled experiments (such as analyzing the effectiveness of code reading versus functional testing) to large, multiple-project studies (such as assessing the impacts of Ada on a production environment). The key findings that NASA feels have laid the foundation for ongoing and future software development and research activities are summarized. Author

N92-19428*# Jet Propulsion Lab., California Inst. of Tech., Pasadena.

JPL'S REAL-TIME WEATHER PROCESSOR PROJECT (RWP) METRICS AND OBSERVATIONS AT SYSTEM COMPLETION

ROBERT E. LOESH, ROBERT A. CONOVER, and SHAN MALHOTRA *In* NASA. Goddard Space Flight Center, Proceedings of the 15th Annual Software Engineering Workshop 26 p Nov. 1990

(Contract NAS7-918)

Avail: NTIS HC/MF A99 CSCL 09/2

As an integral part of the overall upgraded National Airspace System (NAS), the objective of the Real-Time Weather Processor (RWP) project is to improve the quality of weather information and the timeliness of its dissemination to system users. To accomplish this, an RWP will be installed in each of the Center Weather Service Units (CWSUs), located in 21 of the 23 Air Route Traffic Control Centers (ARTCCs). The RWP System is a prototype system. It is planned that the software will be GFE and that production hardware will be acquired via industry competitive procurement. The ARTCC is a facility established to provide air traffic control service to aircraft operating on Instrument Flight Rules (IFR) flight plans within controlled airspace, principally during the en route phase of the flight. Covered here are requirement metrics, Software Problem Failure Reports (SPFRs), and Ada portability metrics and observations. Author

N92-19432*# Reifer Consultants, Inc., Torrance, CA.

REUSE METRICS AND MEASUREMENT: A FRAMEWORK

DONALD J. REIFER *In* NASA. Goddard Space Flight Center, Proceedings of the 15th Annual Software Engineering Workshop 20 p Nov. 1990

Avail: NTIS HC/MF A99 CSCL 09/2

The lessons learned and experience gleaned are described by those who have started to implement the reuse metrics and measurement framework used in controlling the development of common avionics and software for its affiliated aircraft programs. The framework was developed to permit the measurement of the long term cost/benefits resulting from the creation and use of Reusable Software Objects (RSOs). The framework also monitors the efficiency and effectiveness of the Software Reuse Library (SRL). The metrics and measurement framework is defined which was established to allow some determinations and findings to be

made relative to software reuse. Seven criteria are discussed which were used to guide the establishment of the proposed reuse framework. Object recapture and creation metrics are explained along with their normalized use in effort, productivity, and quality determination. A single and multiple reuse instance version of a popular cost model is presented which uses these metrics and the measurement scheme proposed to predict the software effort and duration under various reuse assumptions. Studies in using this model to predict actuals taken from the RCI data base of over 1000 completed projects is discussed. Author

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PHYSICS

Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy physics; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.

A92-24628

OPTICAL DESIGN OF DUAL COMBINER HEAD-UP DISPLAYS

ANTHONY J. KIRKHAM (Pilkington Optronics, Saint Asaph, Wales) IN: International Lens Design Conference, Monterey, CA, June 11-14, 1990, Proceedings. Bellingham, WA, Society of Photo-Optical Instrumentation Engineers, 1990, p. 310-315.
Copyright

Optics for head-up displays (HUDs) with two combiners are reviewed with respect to aberration correction and the optimization of the azimuth field. The impetus for utilizing two combiners is discussed by comparison with conventional HUD designs, and the requirements for aberration correction are listed. The use of a CRT that incorporates the P-53 phosphor is shown to increase the azimuth instantaneous FOV (IFOV), and HUDs with dual combiners enhance the elevation IFOV. A dual-combiner HUD is shown to require a P-1 phosphor CRT, improved color correction, a reduced Petzval sum, and aberration control that is extended over more of the pupil as compared to single-combiner HUDs. The P-53 phosphor can be used to filter spectral sidebands and thereby permit the use of a lens that is not capable of good chromatic correction as well as enhance the azimuth IFOV without changing the module depth. C.C.S.

A92-25365

SOUND PRODUCED BY AN AERODYNAMIC SOURCE ADJACENT TO A PARTLY COATED, FINITE ELASTIC PLATE

M. S. HOWE (BBN Laboratories, Inc., Cambridge, MA) Royal Society (London), Proceedings, Series A - Mathematical and Physical Sciences (ISSN 0962-8444), vol. 436, no. 1897, Feb. 8, 1992, p. 351-372. refs
(Contract N00167-87-C-0021)
Copyright

Results of an analysis of the scattering of bending waves at the edge of an unbaffled thin elastic plate in the presence of arbitrary fluid loading are presented. Detailed predictions are made of the sound scattered from free and clamped edges, and empirical formulas are given for the radiation loss factor over a range of frequencies and fluid loadings. Application is made to the generation of sound by an aerodynamic dipole source adjacent to a finite plate, a finite length of which was treated with damping material. When the edges can vibrate freely, it is shown that a relatively modest amount of damping is sufficient to reduce the edge-generated sound to levels below those of the direct radiation. The efficiency with which bending wave energy is converted into sound is much larger for clamped edges, and larger values of coating loss factor and length are necessary to achieve significant reductions in the structural component of the radiated sound. P.D.

A92-25578

IMPORTANCE OF AN ACCURATE PREDICTION OF SHOCK CURVATURE FOR HIGH-SPEED ROTOR NOISE

JEAN PRIEUR (ONERA, Chatillon, France) American Helicopter Society, Journal (ISSN 0002-8711), vol. 37, Jan. 1992, p. 82-85. refs
Copyright

The ONERA quadrupolar code is presently used in the frequency domain in order to perform high-speed rotor noise predictions, under various assumed shock geometries. The results thus obtained are compared with experimental data. It appears that the calculation results are highly shock-curvature dependent. High-speed impulsive rotor noise reduction may be achievable through a blade design which bends the shock in the rotation plane rearward. O.C.

A92-26232*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

DIRECT COMPUTATION OF THE SOUND FROM A COMPRESSIBLE CO-ROTATING VORTEX PAIR

BRIAN E. MITCHELL, SANJIVA K. LELE (Stanford University, CA), and PARVIZ MOIN (NASA, Ames Research Center, Moffett Field; Stanford University, CA) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 10 p. Research supported by U.S. Navy. refs
(AIAA PAPER 92-0374) Copyright

The far-field sound from corotating vortices is computed by direct computation of the unsteady, compressible Navier-Stokes equations on a computational mesh that extends to two acoustic wavelengths in all directions. The vortices undergo a period of corotation followed by a sudden merger. A 2D version of Moehring's equation is developed and used in conjunction with source terms computed in the simulation to predict the far-field sound. The prediction agrees with the simulation to within 3 percent. Results of far-field pressure fluctuations for an acoustically noncompact case are also presented for which the prediction is 66 percent too high. Results also indicate that the monopole contribution of 'viscous sound' is negligible for this flow. Author

A92-26328*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.

COMPUTATION OF SUPERSONIC JET MIXING NOISE FOR AN AXISYMMETRIC CD NOZZLE USING K-EPSILON TURBULENCE MODEL

A. KHAVARAN (NASA, Lewis Research Center; Sverdrup Technology, Inc., Cleveland, OH), E. A. KREJSA, and C. M. KIM (NASA, Lewis Research Center, Cleveland, OH) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 15 p. Previously announced in STAR as N92-14795. refs
(AIAA PAPER 92-0500)

The turbulent mixing noise of a supersonic jet is calculated for a round convergent-divergent nozzle at the design pressure ratio. Aerodynamic computations are performed using the PARC code with a k-epsilon turbulence model. Lighthill's acoustic analogy combined with Ribner's assumption is adopted. The acoustics solution is based upon the methodology followed by GE in the MGB code. The source correlation function is expressed as a linear combination of second-order tensors. Assuming separable second-order correlations and incorporating Batchelor's isotropic turbulence model, the source term was calculated from the kinetic energy of turbulence. A Gaussian distribution for the time-delay of correlation was introduced. The computational fluid dynamics (CFD) solution was used to obtain the source strength as well as the characteristic time-delay of correlation. The effect of sound/flow interaction was incorporated using the high frequency asymptotic solution to Lilley's equation for axisymmetric geometries. Acoustic results include sound pressure level directivity and spectra at different polar angles. The aerodynamic and acoustic results demonstrate favorable agreement with experimental data. Author

A92-26353
COMBAT AIRCRAFT JET ENGINE NOISE STUDIES [ETUDES SUR LE BRUIT DES TURBOREACTEURS APPLICABLES AUX AVIONS DE COMBAT]
S. LEWY, G. FOURNIER (ONERA, Chatillon, France), and M. PIANKO (Icare, Massy, France) (NATO, AGARD, Symposium on Combat Aircraft Noise, 78th, Bonn, Federal Republic of Germany, Oct. 23-25, 1991) ONERA, TP no. 1991-192, 1991, 18 p. In French. refs
(ONERA, TP NO. 1991-192)
Methods of noise prediction and attenuation, based on results obtained in civil applications are presented. Input data for directivity and radiation forecasts are given by measurements of vane and blade pressure fluctuations, and by modal analysis of the spinning waves propagating in the inlet duct. Attention is given to sound generation mechanisms for subsonic and supersonic single jets and bypass jets. Prediction methods, based on Lighthill's equation (tensor due to the turbulence), are discussed, and the various means of jet noise reduction are reviewed. The CEPRA 19 anechoic wind tunnel, which is primarily designed for studying the jet noise radiated in the far field with flight effects is described. R.E.P.

A92-26362
MODIFICATION OF THE RADIATED SOUND DIRECTIVITY DUE TO GROUND REFLECTIONS - APPLICATION TO STATIC TESTS OF HELICOPTER TURBOSHAFT ENGINES
S. LEWY and H. GOUNET (ONERA, Chatillon, France) (Inter-Noise 91, Conference, Sydney, Australia, Dec. 2-4, 1991) ONERA, TP no. 1991-210, 1991, 5 p. refs
(ONERA, TP NO. 1991-210)
It is well known that wave interferences due to ground reflection modify the shape of acoustic spectra. However, ground effects on the directivity patterns radiated by a noise source are less documented. As explained in the first section, the study is based on some discrepancies between predictions and tests performed on a Malika helicopter turboshaft engine in the Turbomeca's outdoor facility. The three-dimensional theoretical model of ground reflection is described in the second section, and is now included in the prediction program. Finally, it is shown that the new computations are in good agreement with the experimental results. Author

A92-26363
EXPERIMENTAL STUDY OF THE EFFECTS OF ATMOSPHERIC TURBULENCE ON SOUND PROPAGATION OVER THE GROUND
S. LEWY and S. CANARD-CARUANA (ONERA, Chatillon, France) (Inter Noise 91, Sydney, Australia, Dec. 2-4, 1991) ONERA, TP no. 1991-211, 1991, 5 p. Research supported by DRET. refs
(ONERA, TP NO. 1991-211)
Studies on long range sound propagation over the ground were initiated at ONERA several years ago, with the final scope of detecting military helicopters and artillery batteries. They can also lead to some applications on lateral attenuation of aircraft noise. Two basic series of tests over about 1 km, using a pulsed electroacoustic source, were performed. The effects of atmospheric turbulence are discussed. Author

A92-26383
NUMERICAL METHODS IN ELASTOACOUSTICS IN THE NONMODAL DOMAIN [METHODES NUMERIQUES EN ELASTOACOUSTIQUE DANS LE DOMAINE NON MODAL]
C. SOIZE (ONERA, Chatillon, France) (Societe Francaise des Mecaniciens, Congres, Senlis, France, Mar. 26-28, 1991) ONERA, TP no. 1991-232, 1991, 27 p. In French. Research supported by Direction des Constructions Navales, DRET, and ONERA. refs
(ONERA, TP NO. 1991-232)
Numerical methods are presented which have been developed to predict the dynamic behavior and acoustic radiation of structures in the nonmodal medium-frequency (MF) domain. A formulation is presented that appears to be well suited for the nonmodal MF domain, considering the case of strong coupling between the structure, the external fluid, and the internal fluids. The case of weak coupling between the structure and the external fluid, or the structure and an arbitrary internal fluid is also examined. Several applications of this approach are discussed, including internal noise in a helicopter cabin, the proper noise of a sonar dome, and the acoustic emission of a submarine. The capabilities and limitations of the numerical methods examined here are discussed. L.M.

A92-26405* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SOUND GENERATION BY A STENOSIS IN A PIPE
J. C. HARDIN (NASA, Langley Research Center, Hampton, VA) and D. S. POPE (Lockheed Engineering and Sciences Co., Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 30, Feb. 1992, p. 312-317. Previously cited in issue 02, p. 227, Accession no. A91-12435. refs
Copyright

A92-26406* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
SOUND TRANSMISSION THROUGH A HIGH-TEMPERATURE ACOUSTIC PROBE TUBE
TONY L. PARROTT and WILLIAM E. ZORUMSKI (NASA, Langley Research Center, Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 30, Feb. 1992, p. 318-323. Previously cited in issue 02, p. 233, Accession no. A91-12504. refs
Copyright

A92-26441
PRANDTL-MEYER FUNCTION FOR DENSE GASES
M. S. CRAMER and A. B. CRICKENBERGER (Virginia Polytechnic Institute and State University, Blacksburg) AIAA Journal (ISSN 0001-1452), vol. 30, Feb. 1992, p. 561-564. refs
(Contract NSF CTS-89-13198)
Copyright
The present consideration of the nonclassical behavior of the Prandtl-Meyer function in the dense-gas regime shows the function to decrease, rather than increase, with Mach number: at densities, temperatures, and Mach numbers such that the (equation-defined) parameter J is positive. The J-greater-than-0 condition is shown to be easily encountered in fluids, albeit only at pressures and temperatures which correspond to the dense gas regime. The nonclassical behavior may be expected in heavier hydrocarbons and fluorocarbons, rather than such light substances as He or molecular N. O.C.

A92-26930*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
A SURVEY OF THE BROADBAND SHOCK ASSOCIATED NOISE PREDICTION METHODS
CHAN M. KIM, EUGENE A. KREJSA (NASA, Lewis Research Center, Cleveland, OH), and ABBAS KHAVARAN (NASA, Lewis Research Center, Cleveland; Sverdrup Technology, Inc., Brook Park, OH) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 25 p. Previously announced in STAR as N92-14797. refs
(AIAA PAPER 92-0501) Copyright
Several different prediction methods to estimate the broadband shock associated noise of a supersonic jet are introduced and compared with experimental data at various test conditions. The nozzle geometries considered for comparison include a convergent and a convergent-divergent nozzle, both axisymmetric. Capabilities and limitations of prediction methods in incorporating the two nozzle geometries, flight effect, and temperature effect are discussed. Predicted noise field shows the best agreement for a convergent nozzle geometry under static conditions. Predicted results for nozzles in flight show larger discrepancies from data and more dependable flight data are required for further comparison. Qualitative effects of jet temperature, as observed in experiment, are reproduced in predicted results. Author

A92-26931*# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
BROADBAND SHOCK ASSOCIATED NOISE FROM SUPERSONIC JETS MEASURED BY A GROUND OBSERVER
CHRISTOPHER K. W. TAM (Florida State University, Tallahassee) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 11 p. refs
(Contract NAG1-421)
(AIAA PAPER 92-0502) Copyright

The theory of broadband shock associated noise from supersonic jets in flight previously developed in the nozzle fixed coordinates is extended to the coordinate system of a stationary ground observer. The extended theory is relevant to community noise and aircraft certification noise prediction. Since the noise source is unaffected by which coordinate system of reference the radiated noise is measured, the same noise source model is retained in the present formulation. Only kinematic arguments are needed in the analysis. A formula for the noise power spectrum as measured by a ground observer is derived. The formula is applicable to hot as well as cold jets. This formula exhibits a form of Doppler shift in the noise spectrum. However, there is no high power convective amplification factor as some other investigators have proposed. Author

A92-27855
AN AEROACOUSTIC MODEL ABOUT THE ROTATING STALL OF A COMPRESSOR
XIAOFENG SUN, ZONGAN HU, YUCHENG FENG, and SHENG ZHOU (Beijing University of Aeronautics and Astronautics, People's Republic of China) Acta Aeronautica et Astronautica Sinica (ISSN 1000-6893), vol. 12, Sept. 1991, p. A467-A473. In Chinese. refs

An aeroacoustic model about the rotating stall of a compressor is described. The acoustic nature of rotating stall can be preliminarily explained using this model. Based on an analysis of the nature of the frequency and propagation of sound from rotating stall, an acoustic measurement method for characteristic parameters such as the number and propagation speed of a stall cell can be obtained. Initial experimental results from a transonic axial compressor show that this method is feasible. The sound pressure produced by rotating stall is numerically analyzed for the change of width of the stall zone and the number and sound propagation speed of the stall cell. C.D.

A92-28032* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
IDENTIFICATION OF HELICOPTER NOISE USING A NEURAL NETWORK
RANDOLPH H. CABELL (NASA, Langley Research Center, Hampton; Virginia Polytechnic Institute and State University, Blacksburg), CHRIS R. FULLER, and WALTER F. O'BRIEN (Virginia Polytechnic Institute and State University, Blacksburg) AIAA Journal (ISSN 0001-1452), vol. 30, March 1992, p. 624-630. Previously cited in issue 02, p. 231, Accession no. A91-12486. refs
(Contract NAS1-18471)
Copyright

A92-28037* National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
TRANSITION CONTROL OF INSTABILITY WAVES OVER AN ACOUSTICALLY EXCITED FLEXIBLE SURFACE
L. MAESTRELLO (NASA, Langley Research Center, Hampton, VA) and F. W. GROSVELD (Lockheed Engineering and Sciences Co., Hampton, VA) AIAA Journal (ISSN 0001-1452), vol. 30, March 1992, p. 665-670. Previously cited in issue 02, p. 234, Accession no. A91-12520. refs
Copyright

A92-28190# National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.
ACOUSTIC CHARACTERISTICS AND DYNAMIC STRUCTURAL LOADING OF AN ASTOVL AIRCRAFT IN HOVER
L. K. MITCHELL, THOMAS D. NORUM (NASA, Langley Research Center, Hampton, VA), and ALBERT L. JOHNS (NASA, Lewis Research Center, Cleveland, OH) AIAA, Aerospace Sciences Meeting and Exhibit, 30th, Reno, NV, Jan. 6-9, 1992. 9 p. refs
(AIAA PAPER 92-0370) Copyright

Measurements of surface dynamic loading and freestream acoustics were made for an ASTOVL model in hover, to quantify the effects of elevated temperature on the acoustic field and surface loading. Data were acquired for a many combinations of operating parameters: model height above the ground plane, nozzle pressure ratio, and jet exit stagnation temperature. For many conditions, strong tones were observed, with amplitudes up to 150 dB. The frequencies of the strongest tones were well predicted by a model assuming feedback between the nozzle exit and the ground plane. The model also accounts for many of the variations in frequency observed with changes in model height, nozzle pressure ratio, and jet temperature. Broadband sound pressure levels up to 170 dB were also recorded. The maximum levels occurred at approximately 3 equivalent jet diameters above the ground plane. For the majority of the cases, the increase in noise due to temperature was less than expected based on free jet correlations. Author

N92-18074 ESDU International Ltd., London (England).
PREDICTION OF FAR-FIELD HARMONIC NOISE FROM PROPELLERS Abstract Only
Nov. 1991 17 p
(ESDU-91033; ISBN-0-85679-795-2; ISSN-0307-0115) Avail: ESDU

A FORTRAN program for estimating the discrete frequency free-field noise from an isolated straight blade single propeller which is in uniform motion or stationary in a lossless atmosphere is given. Blade sweep is unlikely, however, to have a significant effect up to tip Mach numbers of 0.9. It is assumed that the noise sources are compact chordwise so that they are line sources; that assumption excludes advanced propellers and prop fans. The input to the program is ambient static pressure and temperature, source/receiver relative geometry, propeller operating conditions, and blade geometry and lift coefficient at a number of radial stations. If the load distribution is not known, a default distribution is provided for which power supplied and propeller thrust generated is required. Predictions are compared with available limited data measured in a wind-tunnel, and a sketch shows a typical correlation. The program is provided on disc as ESDUpac 9133, and information is given on the format for the input and output, illustrated by two worked examples. A graphical method for the maximum harmonic levels from a static propeller is given in ESDU 76020. ESDU

N92-18282*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, OH.
AN EVALUATION OF SOME ALTERNATIVE APPROACHES FOR REDUCING FAN TONE NOISE
JAMES H. DITTMAR and RICHARD P. WOODWARD Feb. 1992 21 p
(NASA-TM-105356; E-6730; NAS 1.15:105356) Avail: NTIS HC/MF A03 CSCL 20/1

The potential of two alternative approaches for reducing fan ton noise was investigated in this study. One of these approaches increases the number of rotor blades to shift the tone noise to higher frequencies that are not rated as strongly by the perceived noise scale. This alternative fan also would have a small number of long chord stator vanes which would reduce the stator response and lower rotor-stator interaction noise. Comparison of the conventional and alternative fan concepts showed that this alternative approach has as large or larger a perceived tone noise reduction potential as the conventional approach. The other alternative, a high Mach number inlet, is evaluated both for its noise attenuation and for its change in noise directivity. Author

N92-19672*# Lockheed Engineering and Sciences Co., Hampton, VA.
AN INTRODUCTION TO HIGH SPEED AIRCRAFT NOISE PREDICTION Interim Report
MARK R. WILSON Feb. 1992 80 p

(Contract NAS1-19000)
(NASA-CR-189582; NAS 1.26:189582) Avail: NTIS HC/MF A05 CSCL 20/1

The Aircraft Noise Prediction Program's High Speed Research prediction system (ANOPP-HSR) is introduced. This mini-manual is an introduction which gives a brief overview of the ANOPP system and the components of the HSR prediction method. ANOPP information resources are given. Twelve of the most common ANOPP-HSR control statements are described. Each control statement's purpose and format are stated and relevant examples are provided. More detailed examples of the use of the control statements are presented in the manual along with ten ANOPP-HSR templates. The purpose of the templates is to provide the user with working ANOPP-HSR programs which can be modified to serve particular prediction requirements. Also included in this manual is a brief discussion of common errors and how to solve these problems. The appendices include the following useful information: a summary of all ANOPP-HSR functional research modules, a data unit directory, a discussion of one of the more complex control statements, and input data unit and table examples. Author

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SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law and political science; and urban technology and transportation.

A92-27450
THE PRICE OF SUCCESS - MITIGATION AND LITIGATION IN AIRPORT GROWTH
PAMELA B. STEIN Journal of Air Law and Commerce (ISSN 0021-8642), vol. 57, Winter 1991, p. 513-556. refs
Copyright

The problems associated with the growth of the Dallas/Fort Worth International Airport are described and legal approaches to mitigate them are discussed. The roles of the federal government, of state and local public agencies, and of the airport proprietor in controlling aircraft noise are addressed. Proprietor liability for inverse condemnation and nuisance, the two most common impacts claimed to be caused by airport activity, is examined. C.D.

A92-28183
TRENDS IN THE SELECTION OF AIRLINERS
JOHN ZIMMERMAN and COLIN C. CLARK (Aviation Data Service, Inc., Wichita, KS) Exxon Air World, vol. 43, no. 3, 1991, p. 8-11.
Copyright

A review is presented of current selection factors that are driving the world's airlines to place short and long term orders for a wide variety of commercial aircraft. Attention is given to leasing instead of buying, noise restrictions, the importance of commonality, and the conversion of older aircraft. Consideration is given to a recent trend in Europe where airline alliances are being formed to study the combined purchase of a common aircraft type. R.E.P.

N92-18309# Committee on Appropriations (U.S. House).
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
In its Departments of Veterans Affairs and Housing and Urban Development, and Independent Agencies Appropriations Bill, 1992 p 63-67 3 Jun. 1991
Avail: Document Room, House of Representatives, Washington, DC 20515 HC free

The House of Representatives Committee on Appropriations recommended a total appropriation for the National Aeronautics and Space Administration (NASA) of 13,651,117,000 dollars in fiscal year 1992, which represents a reduction of 2,070,148,000 dollars below 1991. Funding was suspended for the space station program. Details are given for appropriations in research and development; space flight, control, and data communications; construction of facilities; research and program management; and the Office of Inspector General. Author

N92-18814# Federal Aviation Administration, Cambridge, MA. Research and Special Programs Administration.
BIBLIOGRAPHY OF TECHNICAL REPORTS, 1980 - 1990
MARILYN GROSS (Dynatrend, Inc., Woburn, MA.) Apr. 1991 384 p
(PB92-110691; DOT-VNTSC-RSPA-91-1) Avail: NTIS HC/MF A17 CSCL 05/2

The bibliography lists reports released by the Volpe National Transportation Systems Center from Jan. 1980 to Dec. 1990. Reports are listed by sponsoring agency and are indexed by author, title, subject, report number, and performing organization. GRA

N92-19336# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.
STRUCTURED HYPERMEDIA APPLICATION DEVELOPMENT MODEL (SHADM): A STRUCTURED MODEL FOR TECHNICAL DOCUMENTATION APPLICATION DESIGN M.S. Thesis
PETER W. CASSELL Dec. 1991 126 p
(AD-A244268; AFIT/GIR/LSY/91D-3) Avail: NTIS HC/MF A07 CSCL 12/5

This research was conducted to determine how a Royal Australian Air Force technical maintenance publication could be transformed into a task oriented hypermedia application and to develop a model that could be used for future similar transformations. The model was developed following in-depth analysis of the existing USAF F-15E maintenance publication set and validation was conducted using a prototype developed in HyperWriter, a commercial hypermedia product. The prototype model was based around the performance of three maintenance tasks on an aircraft sub-subsystem and incorporated online user access to the necessary support data for task completion. Publication managers, producers, and users were involved in prototype testing and results validated the model design with limited modification recommendations. Recommended changes were subsequently incorporated in the final model. GRA

N92-19466# Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Systems and Logistics.
A GUIDE FOR THE CONSIDERATION OF COMPOSITE MATERIAL IMPACTS ON AIRFRAME COSTS M.S. Thesis
JEFFREY L. ISOM Sep. 1991 122 p
(AD-A243928; AFIT/GCA/LSQ/91S-3) Avail: NTIS HC/MF A06 CSCL 05/3

This study provides a guide to cost analysts who must consider the impact of composite materials on airframe costs. A literature review was conducted to determine the availability of cost models which incorporate the effect of composites on cost. A number of models are available, but no individual model was found that is applicable for every situation. In order to provide a baseline upon which analysts can compare model results as well as provide guidance in selecting cost drivers, a Delphi survey was conducted. Questionnaire results indicate that composite weight (as a percentage of total weight), composite part complexity, percentage of composites in load-bearing role, composite part size, fabrication technique, and percentage of composites in a low observable role are all potentially significant cost drivers. Delphi results also indicate that engineering and quality assurance labor hours are quite sensitive to composite weight, while manufacturing and tooling hours are more sensitive to composite part complexity. Finally, the Delphi results indicate that, although there are some differences in composite labor hour impacts across aircraft type, there are no discernable patterns to the differences. GRA

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GENERAL

A92-25680
LIGHTER THAN AIR - AN ILLUSTRATED HISTORY OF THE AIRSHIP (REVISED EDITION)
LEE PAYNE New York, Orion Books, 1991, 320 p. refs
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A comprehensive development history and current status evaluation is presented for dirigible designs and roles in both commercial and military aviation. Attention is given to the foundational efforts of Alberto Santos-Dumont, Ferdinand von Zeppelin, and Hugo Eckener, as well as to the initial use of airships as bombers during the First World War and their countering through further development of fighter aircraft, the use of airships in the Arctic expeditions of Nobile and Amundsen, and the R-100 vs R-101 competition in Britain. The development and eventual destruction of the largest German Zeppelin Co. and U.S. Navy rigid airships are detailed, together with the uses of nonrigid airships as convoy escorts during the Second World War. O.C.

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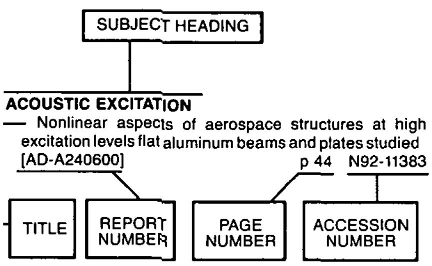

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ADAMS, M. L.
Engine dynamic analysis with general nonlinear finite element codes
[NASA-CR-187222] p 44 N92-11379

TITLE | REPORT NUMBER | PAGE NUMBER | ACCESSION NUMBER

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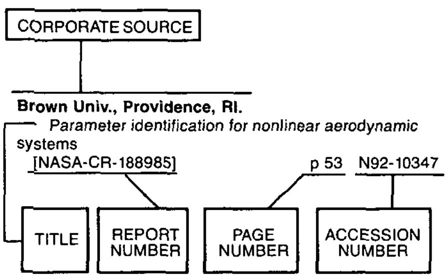

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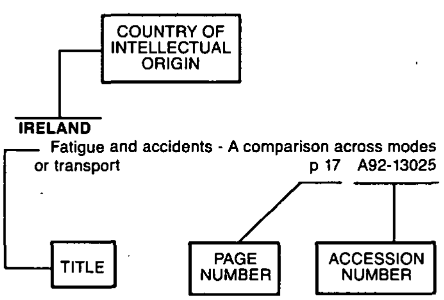

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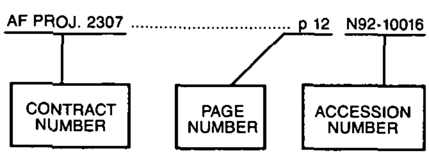

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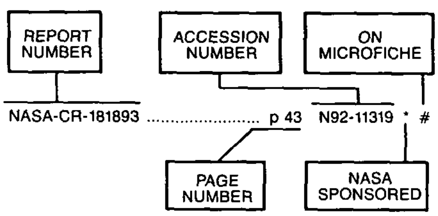

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N92-10002 * # p 2

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